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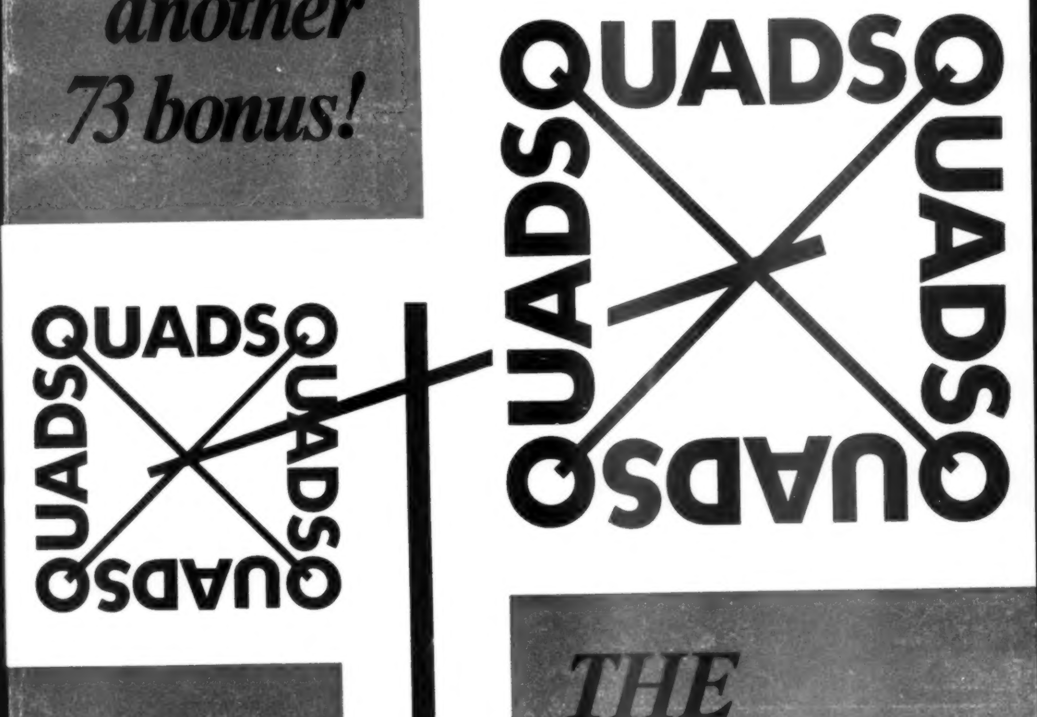
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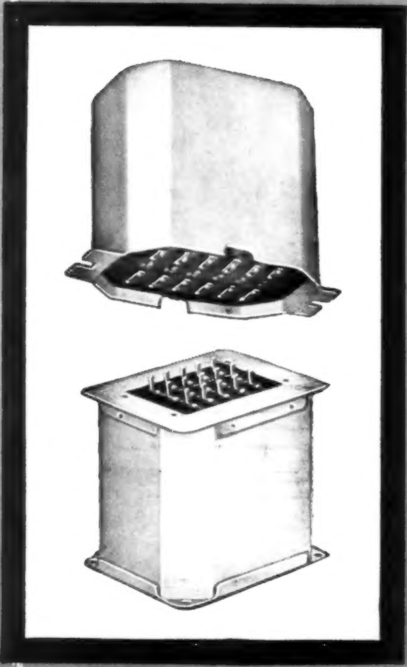

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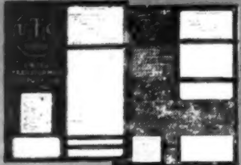

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73 Magazine

May 1967

Vol. XLVI, No. 5

Jim Fisk W1DTY
Editor

Jack Morgan K1RA
Advertising Manager

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The View from Here . . .

As the new editor of 73, I would like to tell you a little about myself. Although I've been an avid amateur since my high school days, it took an army radio school to get me across the CW hurdle to my license. Since that first license in Virginia as K4RPW, I have operated from many places, both in this country and abroad. My latest call is W1DTY, a re-tread that hasn't been seen logged since before the big war.

My electronics background in the military took me into the computer industry, but the abundance of mechanical doodads took me too far away from electronics. A stint as a technician in aerospace cured that and gave me a chance to work intimately with the newest in electronics. However, electronics again fell by the wayside when I was promoted to a papershuffling desk job.

To keep my fingers in electronics, and particularly radio communications, I began writing for 73 and teaching electronics part-time in a junior college. Finally, I wrote to Wayne about employment at 73 – I was rewarded with the opportunity to work with the staff here in Peterborough.

My ham interests are varied. There just isn't enough time to do everything I'd like to do. I like to design and build my own equipment, experiment with new VHF and UHF gadgets, work contests, and just operate in general. Right now my big kick is chasing DX on all bands from 80 through 10. Give me a shout if you hear me on, I'll be glad to chew the fat or give you a New Hampshire contact for WAS. You VHF addicts will have to wait. I put up a beam for six but a windstrom promptly removed a couple of elements, and the New Hampshire snow is not conducive to tower climbing.

In my opinion, and yours too I hope, 73 is the best ham magazine on the market. We have less trivia and more good solid technical and construction articles every month than Brands X and Y put together. If you look back through the more than 2000 articles that we have printed in the past six and a half years, you will find articles on every facet of ham radio.

I will strive to have an article of interest to each of you in every issue. Don't be miffed if we miss you one month, there aren't that many articles written on some topics.

The biggest complaint that I hear centers around late delivery. This has been a continuing problem and we hope to have it licked in a few months. Our present schedule calls for a magazine every three weeks until we get back in the groove. This is a pretty tall order for our skeleton crew, so if we only put out an issue every three and a half weeks, please bear with us–that's still progress!

In the coming months we will have articles on field effect transistors, integrated circuits, and microwaves plus features on antennas, VHF and mobile. If there is sufficient interest, we may even have an article or two on electronic bugging. If you don't see your pet project covered, let me know–better yet, submit an article. A lot of ham authors started by writing for 73. I'll give you all the help I can.

If you get up to New England on your vacation this year, make a point of putting Peterborough on your route. Although you're apt to find the office deserted on the weekends, there's someone here from Monday through Friday. We're not hard to find either, just look for the towers. The very least we'll do is give you a guided tour, introduce you to the staff and try to sell you a life subscription.

If you can't make it to Peterborough, look for me at the conventions and hamfests. Time doesn't allow me to make all of them, but I'll try to get to as many as I can. If you don't find me wandering among the exhibitor's booths or at one of the technical sessions, try the snack bar. I've been known to buy a round of coffee.

Jim, W1DTY

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The SBX-9 Exciter-Driver and the SBA-50 Mixer-Amplifier provide the perfect combination for 50-54mc SSB operation. Performance, versatility and reliability are incorporated into this new SSB pair. A tremendous value at a low price!

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Never Say Die

Wanted: Involvement.

Thousands of amateurs govern their work and their very lives by the movements of DXpeditions. When Gus was scheduled to be on from some rare spot thousands of desks were empty until the contact was made. The DXers are keen and dedicated. You really couldn't ask for more in involvement.

Other thousands of amateurs and equally involved in traffic handling and the traffic nets. Others are hung up on ham-RTTY or ham-TV. Others devote years to a moment or so on moonbounce. Tremendous dedication . . . involvement.

This is good, I think.

One whole big segment of the ham population is almost impossible to lure outside the workshop. They're building things. They don't want to operate . . . to send messages . . . a lot of the time they don't even want to go to dinner or bed. Involvement.

Great!

A few fellows are all whipped up in the politics of ham radio. Some run for ARRL offices and are deeply involved in the League and its workings. Others are generating tremendous quantities of sweat over the Certificate Hunter's Club, the Amateur Radio Editor's Association, and the like.

But ham radio is not DXing, or traffic handling, or the ARRL, QSL'ing, AREA, or building gear. Ham radio is all of these put together, plus all other facets of our hobby. It is the total. And here is where we most desperately need involvement. Each aspect of our hobby has plenty of support, but the lack of fellows interested in the future of the total may be our undoing.

Is there anything that can be done about this? Ham radio is in reality not one hobby, but a whole group of hobbies and it takes an unreconstructed idealist to fight for something that he personally isn't particularly interested in. You don't see many DXers in there battling for reason on the splitting of the two meter band. The traffic men couldn't care less about what is or is not a new country. And so it goes . . . with the result that there is, essentially, no individual ama-

(Turn to page 111)

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The Quad-Quad-Quad

Sixteen three-element quads for two or sixteen nine-element quads for 432 provide a very impressive antenna and signal.

What in devil is a quad-quad-quad? For that matter, what is a quad?

There are two common uses for the word "quad" as applied to antennas. When we put up four antennas in a square formation, we say that we have a quad of antennas. We may have, for example, a quad of 10 element yagis, for a total of 40 elements. The other use of the word applies to quad elements. A quad element is a square of wire, or tubing, which usually has a perimeter of 1 wavelength.

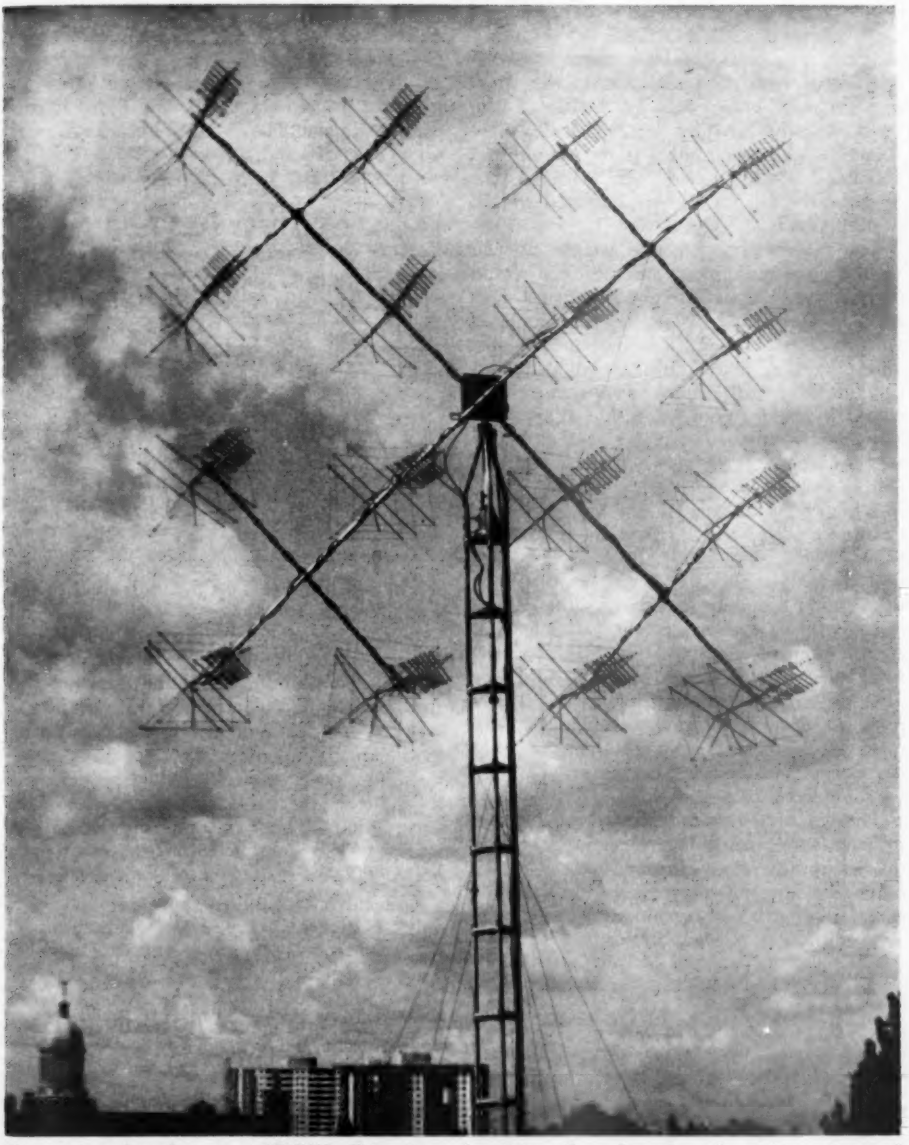
If you make four yagis with quad elements and mount them in a square formation, you have a quad of quads, or a quad-quad. Doug DeMaw described such an antenna in the May 1964 issue of 73. If you put up four quad-quads in a box formation, you have a quad of quad-quads, or a quad-quad-quad. Such a monster is the subject of this article.

In the summer of 1964, I had the booms drilled and the elements cut for four 8-element yagis. Just before buying the tubing to mount the yagis, I overheard Russ, K2KGN, extolling the virtues of his quad-quad, on 2 M. A bit of calculation revealed that it would cost less to start again from scratch and build a quad-quad, than to finish the yagis. The fact that no one else had a quad-quad in Metropolitan Toronto settled the matter. You can't do better than your buddies if you do what they are doing.

In making the quad-quad, my first mistake was the use of aluminum clothesline wire. It sure is nasty stuff to solder. My second mistake was the use of open wire feeders. Open wire is nice if you can keep the wires parallel and you live where there is no rain or snow.

In spite of its deficiencies, the antenna performed fairly well, when the feeders were not shorted.

The advantages of the antenna are low cost and small size for the gain achieved. The elements have gain over straight dipoles, because they are really two half waves spaced a quarter wave apart. This allows you to use shorter booms for a given gain. With three elements, the boom is so short that you can support the boom behind the reflector. This keeps the supporting structure out of the antenna's field, which is always good. It also allows you to mount half of the array below the top of the tower, since the tower will be behind the reflectors. With the center of the array right at the top of the tower, there is no need for a long strong mast to carry the whole weight of the array in a strong wind. Only 2 inches of my mast is between the tower and the bottom of the mounting plates at the center of the array.



The quad-quad-quad array at VE3DNR. This antenna has sixteen three-element quads on two meters and sixteen nine-element quads on 432 MHz.

Designing the beast

After I had the quad-quad up, Russ, K2KGN, put another bug in my brain. How about 16 quads? At first it seemed almost impossible for me. After months of thought, during the winter of 1964-1965, the difficulties disappeared one by one. Measurements and construction were done during the summers of 1965 and 1966.

When you start thinking about a quad-quad-quad, you soon realize that the spacing between yagis will be small, or the beast will be awfully big. A little more thought, with much calculation, reveals that this beast could also be awfully heavy. One of my early designs had a calculated weight of 120 pounds.

You must fight excessive weight as you would when building an aircraft. You would be surprised at the weight of such things as coax. The final design has a calculated weight of 54.4 pounds, including the mast and mounting plates. It is so light that I can lift it by the mast and remove the rotor, which is mounted inside the tower. The mast rotates in a collar at the top of the tower, so it is not necessary to hold it from going sideways.

I wanted to avoid mounting the booms cantilever style, but I still wanted to have the supports behind the reflectors. The solution was to extend the boom on the back side of the supporting tubing, and to put some sort of counter weight on that end. A nine-element quad for 432 MHz has the same weight as a three element quad for 144 MHz. So it was decided to put a 144 quad on one end of each boom and a 432 quad on the other end. The result would be sixteen 3-element quads for 144 and sixteen 9-element quads for 432.

The result had to be as small as possible, so it was necessary to redesign the quads to reduce the size. On the 144 quads, I found that I could bring the reflectors within 14" of the driven element without changing the gain appreciably. The reflector length was tuned for the minimum received signal off the back. The director was not at all critical. As near as I could measure it, the gain of one quad was 8 to 10 dB over a dipole. The front-to-back ratio was about 14 dB and there is a null off the side, as is usual with quad elements.

Side view of an individual quad from the quad-quad-quad array. The nine-element 432 quad is on the left; the three element 2 meter quad on the right.

The design was actually done at 145 MHz, to cover 144 MHz to 145.5 MHz. Antennas usually cover more megahertz below the design frequency than above. When I refer to the 144 quads, I mean the ones designed for the 2 M band, not just 144 MHz.

With the 432 quad directors, I used the idea of a slow wave structure consisting of five equal elements with matching elements at each end. This was described by Loren, K7AAD, in the May 1965 issue of the VHFER. The 432 quads had measured gains of 14 to 15.5 dB.

Measurement

The measurements on the individual quads were performed indoors. Many will look with disdain on such an idea. The main dangers would seem to be the reflections from the surroundings and the effect of the surroundings on the impedance. It was necessary for me to put my hands very near to the quads in order to change their gain. I also observed deep nulls, which would tend to indicate that the reflections were not very serious. The room was not typical. It was a second floor, unfurnished, room with non-metalic insulation.

One advantage of the quad is that it is only a quarter wave wide. Therefore, it does not come as close to obstructions as would an antenna with ordinary dipoles. This would make indoor measurements more feasible with the quad than with the yagi with straight elements.

Measurements were made using the quad as a receiving antenna. A signal generator was connected to a dipole and a super-regenerative receiver was connected to the quad, through 100 feet of RG-58/U cable. There was about 15 feet between the two antennas.

The idea of using a super-regen was to get a sensitive indication of when there was a change in signal. With a large signal present, the super-regen is very insensitive to changes in signal levels. On the other hand, at the receiver's threshold, very small changes in signal can be detected. So the attenuator on the signal generator was varied so that the signal could barely be detected in the receiver. This gave a sensitive indication of when the quad was made better or worse.

The idea of using cheap and dirty RG-58/U for measurements also comes from Loren, K7AAD, in the May 1965 issue of the VHFER. Tuning an antenna for the best SWR does only part of the job. A dummy load gives a fine SWR, but it makes a lousy antenna. What we want is the maximum signal in a 50 ohm load attached to the antenna, in the receiving case. A lossy piece of coax gives its characteristic impedance at one end, no matter what is at the other end. So 100 feet of RG-58/U at 145 MHz will show approximately 50 ohms to our quad, no matter how lousy the receiver's input impedance is.

When we have adjusted our antenna for the maximum received energy, there is no more that we can do. SWR or no SWR, our antenna is putting out as much signal into a 50 ohm load as it can. So, I don't know what the SWR of this antenna is, and I don't care. I have done the best I can.

Characteristics Of quads

There are several features of the quad which should be noted. The square quad, with sides at the top and bottom, works better than the diamond quad, with corners at the top and bottom. The difference is not large, but it is measurable.

As shown on **Fig. 1**, a current maximum will be wherever you feed the quad. Since the quad is 1 wavelength around, the opposite side will have the other current maximum. This puts the current minima, and the voltage maxima, half-way between. With a square quad, the voltage maxima are in the centers of the vertical sides. With the diamond, the voltage maxima are at the side corners. Since it is convenient to have the spreaders supporting the corners, the diamond has supports at its voltage maxima. Unless these supports are high quality insulators, and therefore expensive, you lose quite a bit of power in the supports. The square quad has its supports away from the voltage maxima, and is therefore more efficient.

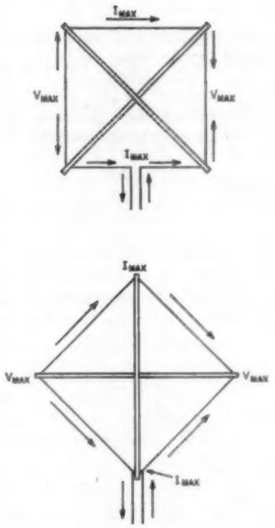


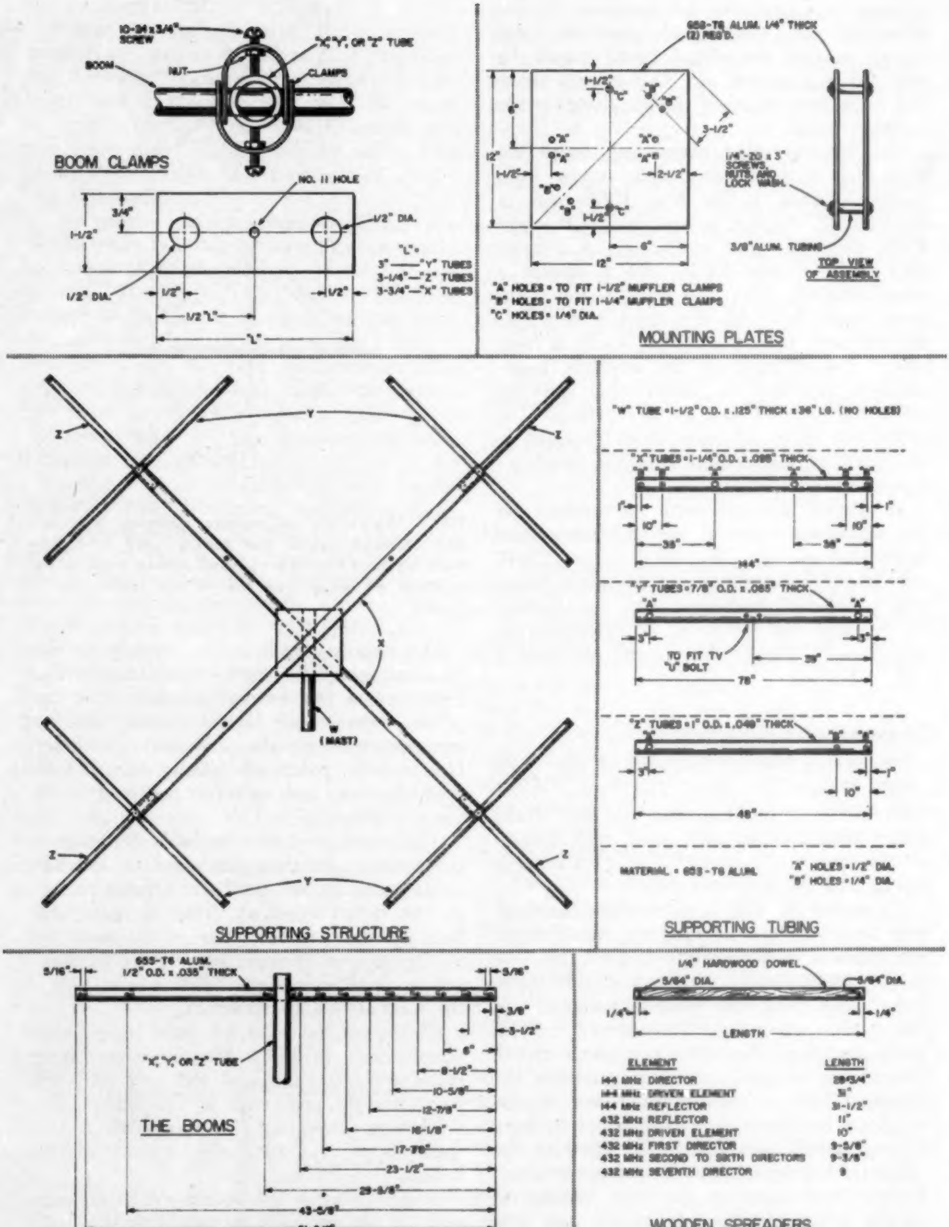
Fig. 1. The current and voltage maximums in square and diamond quads. The square quad is slightly more efficient that the diamond version because the supports are away from the voltage maximums.

For reasons which are a mystery to me, it seems better to solder the directors and reflectors at the current maxima. The opposite seems more logical to me, but my measurements clearly indicated this fact. Horizontally polarized quads should have their directors and reflectors soldered at the top or bottom.

The quad seems to be fairly sensitive to polarization. Rotating the quad on the axis of its boom by 90° produces a large change in the signal received. This is reasonable because the vertical sides of a quad, fed at the top or bottom, have currents flowing in both directions. This would cancel the vertically polarized signal.

The quad seems to be quite happy with unbalanced feeders. Measurements were made with a 432 quad fed with 50 ohm coax straight and with a 1/1 balun. The difference could not be measured. I was quite happy to save the weight of the baluns.

I can guess at the reason. With an ordinary dipole, the side connected to the braid of the coax is connected only to ground. It may get some signal from the other half, but it is operating at a disadvantage. With a quad, all of the element is connected to


10-24 x 3/4" SCREW
BOOM
NUT
"X", "Y", OR "Z" TUBE
CLAMPS
BOOM CLAMPS
NO. 11 HOLE
3/4"
1-1/2"
1/2" DIA.
1/2" DIA.
"L" =
3" ——— "Y" TUBES
3-1/4" — "Z" TUBES
3-3/4" — "X" TUBES
1/2"
1/2"
1/2 "L"
"L"
6S3-T6 ALUM. 1/4" THICK (2) REQ'D.
1-1/2"
"C"
"B"
"B"
6"
3-1/2"
"A"
"A"
"A"
"A"
12"
1-1/2"
2-1/2"
"B"
"B"
1-1/2"
"C"
6"
12"
1/4"-20 x 3" SCREWS, NUTS, AND LOCK WASH.
3/8" ALUM. TUBING
TOP VIEW OF ASSEMBLY
"A" HOLES = TO FIT 1-1/2" MUFFLER CLAMPS
"B" HOLES = TO FIT 1-1/4" MUFFLER CLAMPS
"C" HOLES = 1/4" DIA.
MOUNTING PLATES
Z
Y
Z
X
W (MAST)
Z
Y
Z
SUPPORTING STRUCTURE
"W" TUBE = 1-1/2" O.D. x .125" THICK x 36" LG. (NO HOLES)
"X" TUBES = 1-1/4" O.D. x .095" THICK
"B"
"B"
"A"
"A"
"B"
"B"
1"
10"
38"
144"
1"
10"
38"
"Y" TUBES = 7/8" O.D. x .065" THICK
"A"
"A"
3"
TO FIT TV "U" BOLT
39"
78"
3"
"Z" TUBES = 1" O.D. x .049" THICK
"A"
"B"
"B"
3"
1"
10"
48"
MATERIAL = 6S3-T6 ALUM.
"A" HOLES = 1/2" DIA.
"B" HOLES = 1/4" DIA.
SUPPORTING TUBING
5/16"
6S3-T6 ALUM. 1/2" O.D. x .035" THICK
5/16"
3/8"
3-1/2"
6"
8-1/2"
10-5/8"
12-7/8"
16-1/8"
17-7/8"
23-1/2"
29-5/8"
43-5/8"
51-5/8"
52"
"X", "Y", OR "Z" TUBE
THE BOOMS
1/4" HARDWOOD DOWEL
5/64" DIA.
5/64" DIA.
1/4"
1/4"
LENGTH
WOODEN SPREADERS

ELEMENT	LENGTH
144 MHz DIRECTOR	28-3/4"
144 MHz DRIVEN ELEMENT	31"
144 MHz REFLECTOR	31-1/2"
432 MHz REFLECTOR	11"
432 MHz DRIVEN ELEMENT	10"
432 MHz FIRST DIRECTOR	9-5/8"
432 MHz SECOND TO SIXTH DIRECTORS	9-3/8"
432 MHz SEVENTH DIRECTOR	9

Fig. 2. Constructional details of the quad-quad-quad. The type of construction shown here results in a very strong unit that only weighs about 55 pounds.

the inner conductor, since the element is one piece of wire. It would seem that the quad element would be happier operating as an unbalanced antenna than would an ordinary dipole.

I see no reason to believe that there will be less fading with a large antenna. Although it is true that a signal will be received even if one quad is receiving nothing, it is also true that all the quads could be receiving something, but they could cancel each other. To me, one QSB situation seems as likely as the other.

If you want diversity reception, you must feed the signals from more than one antenna to more than one receiver, and add the audio signals. Only at audio frequencies can you keep the signals from the various antennas in phase. The 16 quads would seem to be good for a four channel diversity system. You could have the four quad-quads polarized horizontally, vertically and at the two 45° angles.

Construction

To save weight, the elements were made of #14 wire instead of the #10 used by Doug DeMaw. This may account for his superior front-to-back ratio. #10 wire for only the reflectors, which seem to be the most critical elements, may be a good idea. The spreaders were made of ¼" dowel instead of ⅜".

The position of the holes in the booms are specified by Fig 2. The booms were drilled with ¼" holes so that the spreaders could be passed through the booms. This saves the weight of the circular hubs that Doug used. The booms are very thin. There is danger that you will bend the booms where the holes are drilled. I bent one while installing the antenna. Since an individual quad is light, it can't do much damage if it falls. Therefore, we can take the chance that we have made the booms too thin.

It looks much better if you can make the holes in the boom line up; it looks less of a mess to the neighbors if the elements are in a line. A drill press is handy, but you can do a fair job with an ordinary electric drill. I doubt that perfect alignment will improve the electrical properties of the antenna.

The size of the elements have been given by specifying the lengths of the spreaders in Fig. 2. If the wire is under a *bit* of tension, you will come very close to getting the right perimeter every time. Even if the wire does not form a perfect square, the perimeter comes out roughly the same if the spreaders are the right lenght. The dimensions are not very critical. If you *try* to make the distance between the holes on the spreaders accurate, you should have more than enough accuracy.

Before putting the spreaders through the boom, you will find that you must file the holes in the booms. If you file the hole only enough to get the spreader in, you will need no adhesive to keep the spreader centered in the hole. It is easier on the nerves if the spreader stays put while you are trying to put the wire in place.

The booms are put through ⅝" holes in the supporting tubing. Therefore, you can only wire the quad on one end of the boom before putting the boom in the ⅝" hole. Since the 432-MHz quads have three times as many elements as the 144-MHz quads, you will naturally make the 432 quads first. You want to string as many elements as possible before getting the booms involved with the supporting tubing.

The ends of the spreaders were painted

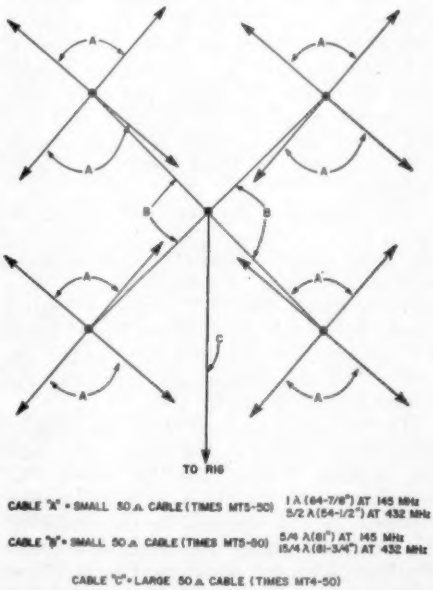

A
A
A
A
B
B
A
A
A
A
C
TO RIG
CABLE "A" • SMALL 50 Ω CABLE (TIMES MT5-50) 1 λ (64-7/8") AT 145 MHz 5/2 λ (54-1/2") AT 432 MHz
CABLE "B" • SMALL 50 Ω CABLE (TIMES MT5-50) 5/4 λ (81") AT 145 MHz 15/4 λ (81-3/4") AT 432 MHz
CABLE "C" • LARGE 50 Ω CABLE (TIMES MT4-50)

Fig. 3. Cable assembly required for feeding the quad-quad-quad; all the sections of the cable assembly are made from low-loss 50 ohm coaxial line.

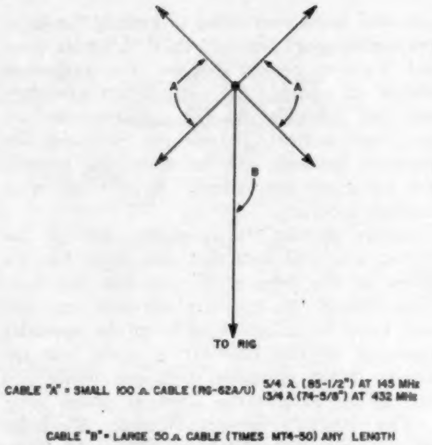

A
A
B
TO RIG
CABLE "A" = SMALL 100 Ω CABLE (RG-62A/U) 5/4 λ (85-1/2") AT 145 MHz
13/4 λ (74-5/8") AT 432 MHz
CABLE "B" = LARGE 50 Ω CABLE (TIMES MT4-50) ANY LENGTH

Fig. 4. Cable assembly for feeding a four quad quad-quad; this assembly uses both 100 ohm and 50 ohm coaxial line to obtain the proper impedance transformation to the main 50 ohm coaxial line.

with General Cement's Liquid Tape to cover the holes where the wire goes through. Then the whole spreader was painted with marine spar varnish.

The means of holding the booms in the ½" holes is one of the standard methods. The clamps are described by **Fig. 2**. Probably only one clamp per boom is necessary, but they are light and one clamp seemed marginal to me. Of course, you could weld the booms in place, if you know that you will never want to take it apart. Surely you will want to build something bigger in future.

The supporting structure was put in the form of a X frame. (**Fig. 2**) instead of the more usual H frame. This arrangement was used because it seemed lighter for a given strength. My only regret is that it would have been easier to tilt the H frame for moonbounce. Since I don't have the equipment for moonbounce activities, this doesn't bother me much.

The mounting plates (**Fig. 2**) are clamped to opposite sides of the mast (W) with 1½" muffler clamps. The 1¼" tubes (X) are clamped to the plates with 1¼" muffler clamps. To add strength to the assembly, ⅜" aluminum tubes are wedged between the two plates, as shown in **Fig. 2**. These tubes are held in place by ¼" screws which go through both plates and the ⅜" tubes. With this arrangement, each plate helps to keep the other plate from rotating around the mast in a wind. I can't tell you what holes to drill for the muffler clamps because your clamps will probably be different from mine.

The Z tubes fit inside the X tubes and 2" from the ends of the X tubes, using TV "U" bolts. Since you probably will use different "U" bolts from mine, I can't tell you what holes to drill in the Y tubes. The Y tubes are bolted to the same side of the X tube as its mounting plate. This makes it easier to line up the quads.

The Z tubes fit inside the Xtubes and are fastened with ¼–20 screws, 1⅜" long. The holes in all the supporting tubes are specified by **Fig. 2**.

Since the X tubes are separated by the plates and the mast, we must compensate for the space between them. All of the quads must line up as close as possible so that they are all the same distance from the other fellow's station. Otherwise, the signals from the 16 quads will not add in phase. This is, of course, more critical at 432 MHz than at 144 MHz.

The booms in the X and Z tubes are pushed toward the *center* of the array as much as possible. By the center of the array, I mean a line drawn parallel to the X tubes which passes through the mast. The booms in the Y tubes are pushed (in my case) ⅜" away from the centers of the booms in the direction of the center of the array. The exact distance depends on the dimensions of your muffler clamps. This should make the quads line up to within ½" or so. You must also be careful that the Y tubes are clamped to the X tubes properly to make the quads line up. Finally, when clamping the X tubes to the plates you must rotate the X tubes so that the quads line up.

All of the muffler clamps and "U" bolts must be protected to prevent rust. I used Vaseline, because it is readily available and it has always done the job for me.

The cable harness

The coax connecting the quads together is small, RG-58/U size, cable. Naturally, the larger, RG-8/U size, cable would have lower losses, but more weight. Since the length of the cable from the common junction to any quad is short, the losses in small cable should be small. The additional weight of large cable seemed intolerable. Below the common junction, the weight of the cable is supported by the tower and we can therefore use large cable for the long run to the rig.

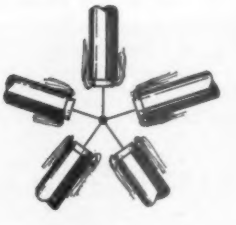
Fig. 3 shows the cable lengths for 16 quads. Each quad is designed to have an impedance of 50 ohms. So when four quads are connected together by 50 ohm cable, we have 50/4 ohms as the total impedance at these junctions. Each of these four junctions is connected to the common junction by 50 ohm cable which is an odd number of quarter waves long. These quarter wave sections transform the 50/4 ohms to 4 x 50 ohms. The main junction sees four 4 x 50 ohm impedances connected in parallel to give 50 ohms. The main cable to the rig is 50 ohms, so it is matched.

The cable used was made by Times Wire & Cable and distributed by Mosley. Any other cable could, naturally, be used if the velocity of propagation is taken into account. The dimensions in inches on **Fig. 3** are for the Times cable. The distance in wavelengths required is, naturally, the same for all types of cables.

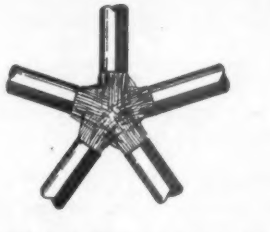
For a four quad array, 100 ohm cable could be used, as in **Fig. 4.** An odd number of quarter waves would transform the 50 ohms of each quad (100/2) to 2 x 100 ohms. Four cables connected together would give ¼ of 2 x 100 ohms or 50 ohms, to match the cable to the rig. The most appropriate cable I can find in the catalogues for the quarter wave sections is RG-62A/U; its impedance is 93 ohms instead of 100 ohms.

You may raise your eyebrows at the idea of connecting the cables without coax connectors. If you count the number of connectors that would be needed for the 16 quads on two bands, you can see the point of avoiding connectors. The weight, let alone the cost, of all those connectors is prohibitive. Therefore, we must do our best at making reasonable coaxial connections with our trusty soldering iron.

The five cables for each connection were laid out like five spokes of a wheel, as shown by **Fig. 5.** The inner conductors were soldered and the joint was insulated with tape. The outer braids were then folded over the tape to cover each side of the joint. The braids were then soldered together to form a solid shield all around the connection. The joint is fairly strong after the braids are soldered. The finished connection is then taped and coated with some weather-proof material. I wouldn't recommend the coating that I used, so there is not much point in naming it.



(A) SOLDER THE INNER CONDUCTORS AND TAPE CONNECTION



(B) FOLD THE BRAID OVER, SOLDER, AND TAPE AGAIN

Fig. 5. Connecting the coaxial cables together without using connectors. The coaxial connectors required for the quad-quad-quad are very expensive and add a lot of weight at the top of the tower.

Of course, you must be careful to connect all the quads in phase. All of the inner conductors must go to one side of the quads (eg. the right sides) and the braids to the other sides (eg. the left sides). If you goof on ½ of the quads, you will have a nice null where the main lobe of the pattern should be. These connections should be coated with something weather-proof.

The cables run up from the driven elements to the booms, along the booms and then along the supporting tubes. The cable is wound around the tubes and taped. The lengths of cable specified include enough slack to route the cable in the same way.

Getting it up

To show that it is possible, I decided to put up the beast alone. Unfortunately, my refusals of offers of help may have rubbed a few relatives, hams and neighbors the wrong way. It seemed important to show that anyone out in the sticks could do the job without help.

The key to success is to have a gin pole, which is a piece of pipe with a pulley on one end. You bolt the pole to whatever is already in the air, with the pulley at the top. Then you pull up whatever is next with a rope running over the pulley. My pole is 12 feet of 1¼" aluminum tubing, with a clothesline divider bolted to one end with a "U" bolt.

The antenna was put up in three sections. The mast and plates were put up first. Then each X tube was put up with all the stuff that each one supports. The two main junctions of the coax (one for each band) were soldered with the antenna in place.

It isn't really easy to do the job yourself, but it is possible.

Performance

The antenna moves in two major directions in a breeze. As you would expect, there is a strong tendency to rotate about the axis of the mast. Since the rotor is of the TV type, it is not strong enough to keep this rotation under control. There is a clamp at the top of the tower, which allows me to lock the mast to the tower. This clamp can be controlled from the ground using a "rope and pulley" system. The system works, but I hope to replace it with some electro-mechanical system that can be controlled from inside the shack. A heavy duty rotor would cost 4½ times as much and it still would not hold the antenna as well as my clamp. I have seen the way that some expensive rotors hold big ham antennas in Toronto and they impress me very unfavorably.

The other motion is rotation around the axis of the 1¼" tubing. This motion is not too severe because it is limited by how far the X tubes will twist. This motion shows that tube Y must be clamped firmly to tube X. Plenty of wind force is available to twist tube Y around the axis of the X tube. Perhaps, in my next model, I will put braces between the X tubes and the Y tubes.

The electrical performance is difficult to state definitely. This antenna is the first one at this QTH which was made at all properly. There is no well made antenna at the same height that I can use for comparison.

Comparing my results with others is also not valid. My QTH is not at all average. The 60-foot tower for the antenna sits on land 300 feet above and 1000 feet horizontally from Lake Ontario. The QTH is in Scarborough, the eastern borough of Metropolitan Toronto. To the west, my signal must fight its way across 18 miles of city and climb the Niagara escarpment, 30 miles away, before getting anywhere. To the east, there is smooth sailing over the lake for 150 miles. My coverage very much depends on the direction.

For what it is worth, I can hear W8KAY, Akron, comfortably out of the noise when his beam is on K2IEG. With the four quads, he was just audible. I have gained the ability to work the weaker boys (AM) around Rochester, N. Y. and the tower types in downtown Hamilton. On two occasions I have worked dx stations to the west and south immediately after Dennis, VE3ASO, worked them. They reported that my signal was 2 S points better than Dennis's. VE3ASO has 150 watts and 40 elements in a reasonably good suburban location in western Toronto. I have 60 watts.

I have no 432-MHz gear yet, so I can't report on the performance of the 432 quads in actual operation.

Conclusion

The quad can serve all types of two meter hams. Those who have little in funds and space can make one quad. It will fit, and rotate, in the attic or sit in the corner of the apartment balcony. Tell the landlord that it is a work of modern art, which it will be if you do a good job.

The average Joe can put up four quads without stretching the budget much; it should do as well as about 24 ordinary elements in far less space.

The ambitious can put up 16 quads, which might be enough for moonbounce. The 48 quad elements should do as well as 96 ordinary elements. OH1NL had only 24 elements in front of a screen to work W6NDG. You can also use the antenna for earth-bound contacts, because it is small enough to put on a tower. A large parabola on a high tower presents nasty mechanical problems because of the wind.

Why use straight elements, when you can get more gain with quads? Give them a try.

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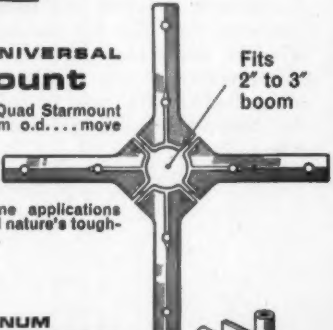

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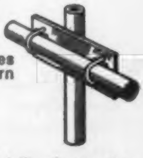

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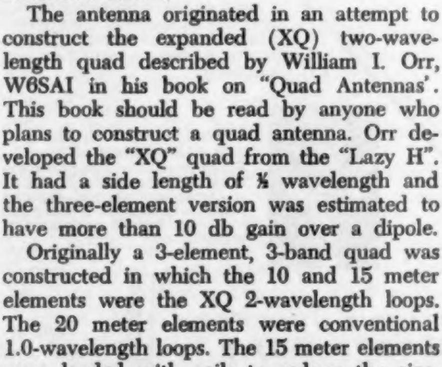
The Expanded Quad

This article describes an experimental expanded quad which is practical to construct and which has considerably more gain and directivity than an ordinary quad of equal elements. A three-element version was constructed which works excellently on 10, 15, 20 and 40 meters.

The antenna originated in an attempt to construct the expanded (XQ) two-wavelength quad described by William I. Orr, W6SAI in his book on "Quad Antennas'. This book should be read by anyone who plans to construct a quad antenna. Orr developed the "XQ" quad from the "Lazy H". It had a side length of ½ wavelength and the three-element version was estimated to have more than 10 db gain over a dipole.

Originally a 3-element, 3-band quad was constructed in which the 10 and 15 meter elements were the XQ 2-wavelength loops. The 20 meter elements were conventional 1.0-wavelength loops. The 15 meter elements were loaded with coils to reduce the size, but they were still larger than the 20 meter ones.

After considerable experimentation, the 2-wavelength XQ was given up because of structural weakness and because the high impedance (2,000-3,000 ohms) at the feed point made matching too difficult.



(a) (b) (c)

Fig. 1. Feedpoints in the current wave for (a), an ordinary 1 wavelength quad, (b), a 2 wavelength quad, and (c), the 1.5 wavelength expanded quad.

During the experimenting it was noticed that the 10 meter XQ had a strong resonance and low impedance at a frequency near the 15 meter band. A check showed that the antenna was 1½ wavelengths at this frequency, and the feed point at the center of the bottom side had an impedance close to 50 ohms.

With the belief that this 1½ wavelength loop would approach the high performance predicted by Orr for the 2-wavelength XQ, the antenna was reconstructed to have 3-element, 1½ wavelength loops for 10 and 15 meters and the 20 meter was left as the standard quad.

All three bands have been satisfactorily matched to a single 52 ohm RGSU coaxial feed line. However, matching would have been simplified and the interaction less if a separate line had been used for the 15 meter antenna.

Numerous contacts and comparative tests have proven the 10 and 15 meter 1½λ XQ's to be very effective. In over 90% of the contacts the S-meter rating received was better than could be given to the contact even though many of them used kilowatt linears in comparison to the 300 watts of the TR3.

Don is a professor at Texas A and M university (Phd Chemical Engineering, Iowa State). He has operated as HC2WH in Quayaquil, Ecuador.

The directivity, front to side and front to back ratios are noticeably better than those of the 20 meter quad which was used for comparison. It is believed that the gain of the 1½λ XQ is close to that estimated by Orr for the 2λ XQ.

An added bonus is that the 15 meter 1½λ antenna works very well as a ½λ folded beam for 40 meters. This was observed after the antenna was erected so no attempt has been made to match it for better SWR or front to back ratio. As it is the SWR is 2.5 at 7.3 mc. and 1.05 at 7.2 mc. The element spacing constructed for 15 meters is much too close for 40 meters and a compromise should be made for more emphasis on the latter band.

Since the 1½λ XQ has performed so well on 10 and 15 meters, a 20 meter version has been planned. In the existing antenna, the spacing between the 15 and 20 meter wires is about 8 inches and there is considerable interaction when using a common feed line. With the 1½λ XQ for both 15 and 20 meters the spacing will be 3½ feet and the interaction should be greatly reduced.

With existing quad antennas, the 10 and 15 meter elements can be readily converted to the 1½λ XQ for improvement in DX operation.

The 20 meter 1½λ XQ requires a side of 25 feet and spreaders 18⅔ feet long. However, this is conservative when compared with some of the beams having 50 ft. booms and weighing 150 lbs. or more. A full size 40 meter quad at W3APO has 25 ft. fiberglass spreaders.

Theory

The reader is again referred to the book on Quad Antennas or the Antenna Handbook for the theory of the XQ and the detailed discussions of quads. Fig. 1 shows the feed-points in the current wave for (a) an ordinary 1.0λ quad, (b) a 2.0λ XQ and (c) the 1.5λ XQ, when the feed is at the center of the bottom side. The impedance of the quad and the 1.5λ XQ is usually between 40 and 75 ohms, while the 2.0λ XQ will be in the enighborhood of 2,000-3,000 ohms. A ¼ wave matching section may be used to reduce the high impedance to that of the line.

Tne ends of the quad are in phase and can be electrically joined, but the 1½λ XQ antenna ends are out of phase and must be separated by an insulation.

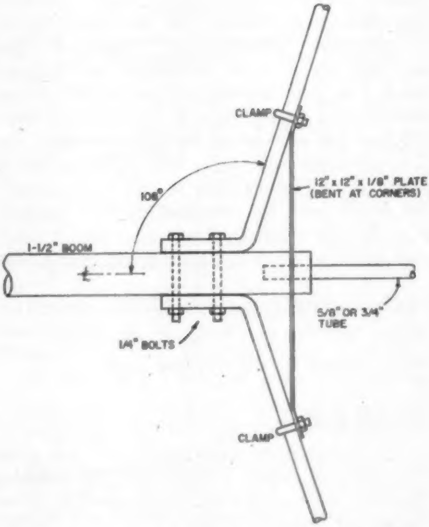


Fig. 2. Attaching the spreaders to the boom.

The 15 meter antenna works on 40 meters since 21 MHz is a third harmonic of 7.0 MHz. Actually if the antenna resonates at 21.4 MHz at 1½ wavelengths it will resonate at 7.14 MHz as a ½ wavelength antenna. Experience has shown that the tuning is broad enough to cover the whole 40 meter band.

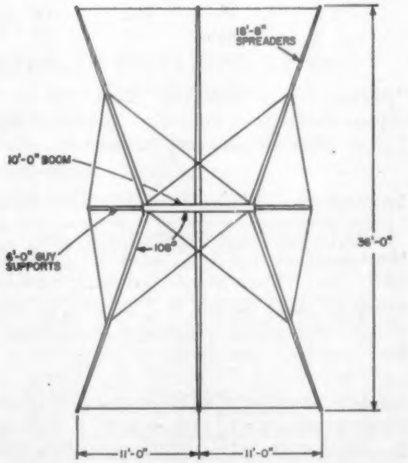


Fig. 3. Side view and dimensions of the XQ.

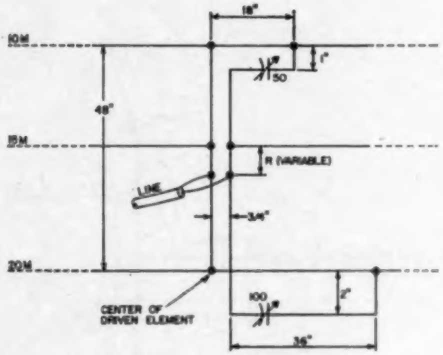


Fig. 4. Match for the expanded quad.

Construction

A construction description will be given for the 3-element, 3-band 1⅝λ XQ antenna. Since it also works on 40 meters, it is actually a 4-bander.

Although a 4-element antenna of this type would give a slightly better performance, it is doubtful if the additional cost, labor, and wind risk is justified. On the other hand a 2-element version would be easier to construct and should have a gain better than 7 dB on all bands except the 40 meter band which would have a gain of 4 or 5 dB over a dipole.

No. 14 solid enameled copper wire is used for the antenna and a little over 8 lbs. is required. The loop sizes are as follows:

Frequency	Director	Driver	Reflector*
14.3	96′	100′	100′
21.4	64′3″	67′	67′
29.0	47′6″	49′6″	49′6″

*Reflectors are kept the same size as the driven elements to minimize spreader length. Either stubs or coils may be used for tuning.

Spreaders

The four front spreaders should be 17′9″, the center ones 17′ 9″, and the back ones 18′8″ long. They should be fairly stiff because of their length and preferably made of fiberglass-plastics. Since it is difficult to find bamboo this long, a combination of 1⅝" or 2" O.D. aluminum tubing and bamboo may be used. The bamboo should be covered with fiberglass plastic or it may be coated with butyl-aluminum roofing paint. Measurements indicated that the aluminum paint had no electrical significance.

Boom

A ten foot length of galvanized steel or aluminum electrical conduit is suggested. This should be 1¼" or 1½" nominal pipe size or a 2" O.D. stiff aluminum tube could be used. The boom is extended at each end with 6 foot lengths of ⅝" or ¾" O.D. light-weight tubing to serve as terminals for attaching the cross-bracing cards.

Assembly

Assembly of this antenna is quite an engineering feat. It was found convenient to attach the boom to a tilting mast in such a way as to permit rotation for access to the spreaders. The spreaders may be attached to the boom with purchased spiders. However, the author used sections of aluminum tubing as part of the spreaders and these were flattened and bolted to the boom as shown in Fig. 2. One foot square stiff aluminum plates were used for bracing.

Fig. 3 shows a section through the boom and center element. This is a diagonal section extending to opposite corners of the quad. Cross bracing with 150 lb. test nylon cord is used to increase strength and the ends of the spreaders are connected with it to hold the proper spacing. For clarity wiring is not shown on the figure.

Adjusting for frequency

Before attaching the connecting network each element was adjusted for proper frequency with a grid dip meter. The exact frequency was obtained by picking up the signal on a receiver. The driver elements were adjusted to 14.3 MHz, 21.4 MHz, and 29.0 MHz. The directors were adjusted to 14.9 MHz, 22.4 MHz and 30.3 MHz. Small tuning coils 2½" diameter, and having a length of wire of about 4% of the element, were used to adjust the reflector frequencies to 13.6 MHz, 20.4 MHz, and 28.0 MHz. Tuning stubs could be used if preferred.

Connecting to the feed line

A single RG8U, 52 ohm, feed line was used and this was connected to the three antennas as shown in Fig. 4. The 48" long header was constructed of No. 12 stiff copper wire and spaced ¾" with micarta insulators. Gamma match connections were made to the 10 and 20 meter antennas and a direct connection was made to the 15 meter antenna. The line was connected to the header about 8" below the 15 meter antenna and the distance was varied to serve as a means for tuning.

The gamma match lengths and capacitances are approximate and are varied to obtain the best match. The values are affected by element spacing, proximity of the band loops, and height above ground.

Temporary variable condensers were used in the gamma matches. When tuning was complete they were replaced by short lengths of RG58U coax experimentally cut to give the same match. These were then sealed to keep out moisture.

Although the SWR is the final test, it is desirable to use an antennascope or impedance meter to make the matching adjustments. The antennascope construction is described in the "Radio Handbook" published by Editors and Engineers.

The method used for matching the 15 meter antenna to the line was made necessary by the interaction between it and the 20 meter quad antenna. With 1½λ XQ should be easier.

Since the gamma match lengths, capacitances, and the feed point are all interacting variables, considerable adjusting is needed to obtain a low SWR for all bands. However, the gamma lengths are not very critical and the 10 meter adjustments are almost independent of the 15 and 20 meter settings. So, after a preliminary adjustment of the capacitor on the 10 meter gamma, an optimization of the 20 meter capacitance and the feed-point setting (R) will bring the system to a fairly close balance.

The final SWR readings after the antenna was raised to 40 feet are shown below. These could have been improved by tuning with the antenna further from the ground.

Freq.	7.3	7.2	14.4	14.2	21.45	21.3	28.5	29.0
SWR	2.5	1.05	1.3	1.75	1.1	1.8	1.6	1.2

The results obtained from this antenna have repaid the trials and tribulations of building it. This includes repair after a windstorm blew it into the trees and a broken arm caused by a rotten ladder breaking under me.

. . . WA5KXY

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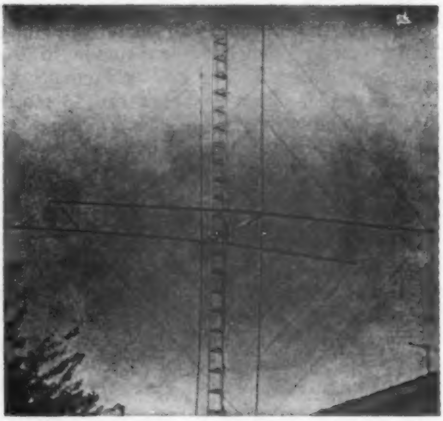
An Inexpensive DX Antenna

Howard Krawetz WA6WUI
654 Barnsley Way
Sunnyvale, Calif.



The increased activity in our ham bands has forced many good amateurs to use high gain directional antennas to obtain good solid contacts. The cubical quad antenna described here is quite directional, has high gain, and is inexpensive when compared to other beams (total cost is about $30).

The antenna is mounted with spreaders running horizontally and vertically rather then diagonally. This enables the metal spider brackets to be welded with greater ease and may also add some strength to the assembly. The spider brackets should be made of ⅜" x ½" x 2′ aluminum angle (4 each required). Weld each pair on centers and at right angles. The spider to boom bracket should be made of ⅛" x 1" x 2′ aluminum angle (2 each required). Weld in the center and at a right angle to the ⅜" wide legs. The metal may be obtained from a junk yard, some supply houses or any welding shop; take the materials to welding school or high school metal shop to be welded.

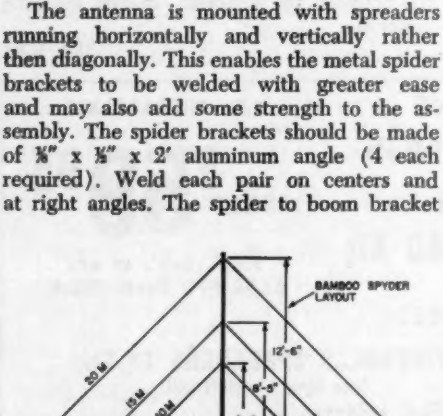


Fig. 1. Complete layout of the three band, two element quad; bamboo poles and a wooden mast provide very economical construction.

The boom to mast support bracket should be made of ⅛" x 1½" x 2′ aluminum angle (2 each required). These two pieces should also be welded to each other at right angles and on centers (see figure 3).

The boom is made of 2" x 2" lumber. One piece is 11 feet long and the other is 6 feet long. These two pieces should be nailed together with the shorter piece centered below the longer piece.

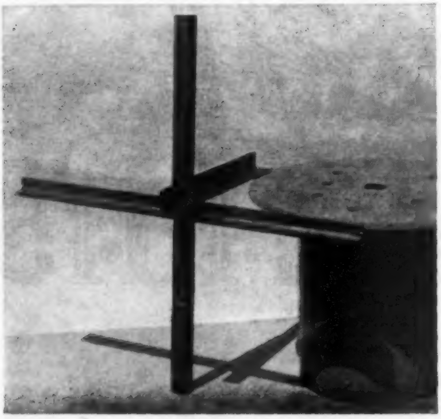
Center the aluminum boom to mast bracket on the boom, drill at least 8 nail holes through the horizontal leg and nail the assembly together.

Obtain the bamboo from a carpet store as carpets often come wrapped around bamboo poles. Try to get unsplit, straight poles 13′ long and the thinner the better. You will need 9 poles and they should not cost over 25 cents each.

Cut up a couple of coat hangers into 3" lengths and form into wire hooks as shown in Fig. 3 inset.

Lay out the bamboo to the dimensions shown in Fig. 1. Drill holes through one side of the bamboo and install the wire hooks into 3 legs of the spider. On the fourth leg drill the holes all the way through the bamboo 1" above and 1" below the laid out dimensions for each spider assembly.

Assemble the bamboo to the spiders using



Construction of the homemade spreader assembly. This bracket is welded together from pieces of aluminum angle.

2 small hose clamps for each pole. Most auto stores have an ample supply of hose clamps in assorted sizes.

For each band, attach one end of the wire through the upper hole on the fourth leg. Wrap the wire around the spider and attach the end through the bottom hole. Attach the feed line to the wire ends on the driven element and solder. Short the wire ends together on the reflector element. Tape over the wire hooks to make sure the wire stays in place as it has a tendency to stretch with time.

Assemble the spiders to the boom with large hose clamps. (This is the toughest part.) Space the elements as shown in Fig. 3.

The last bamboo pole is the stabilizer. Cut it 9′ long, drill a small hole through two small hose clamps and screw them to each end of the pole. Attach the stabilizer about 8′ down on the fourth legs between the elements and parallel to the boom.

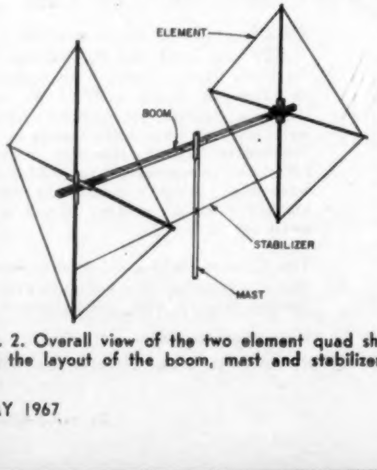


Fig. 2. Overall view of the two element quad showing the layout of the boom, mast and stabilizer.

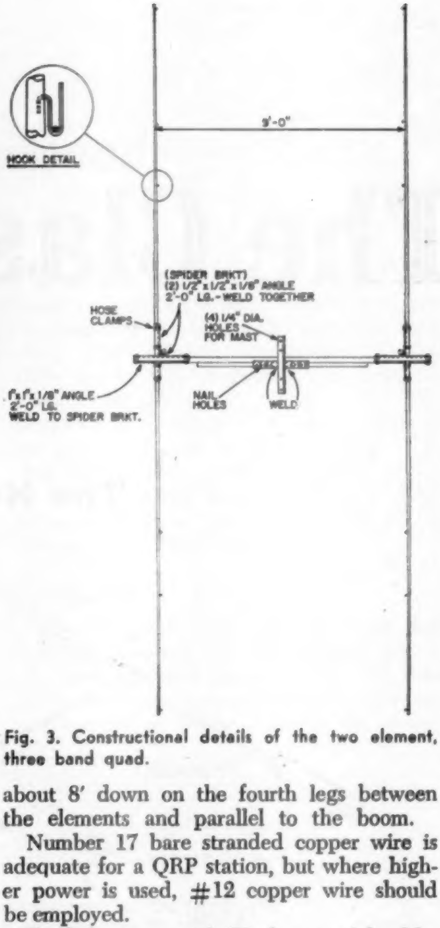


Fig. 3. Constructional details of the two element, three band quad.

Number 17 bare stranded copper wire is adequate for a QRP station, but where higher power is used, #12 copper wire should be employed.

Feed the array with 52 ohm coaxial cable. We found that two of the bands could be fed with the same feed line without appreciable loss, but the other band had to be fed with a separate feed line; this array has 10 and 15 meters on the same feed line with a separate line for 20 meters. It was also found that tuning stubs on the reflector were not absolutely necessary and were omitted from the installation.

We have received Q5 signal reports from Austrailia, New Zealand and Japan with 70 watts on the 10 and 15 meter AM bands. The antenna has been mounted on a 20 foot tower with good results, but much better results are obtained when mounted on a 40 foot tower.

. . . WA6WUI

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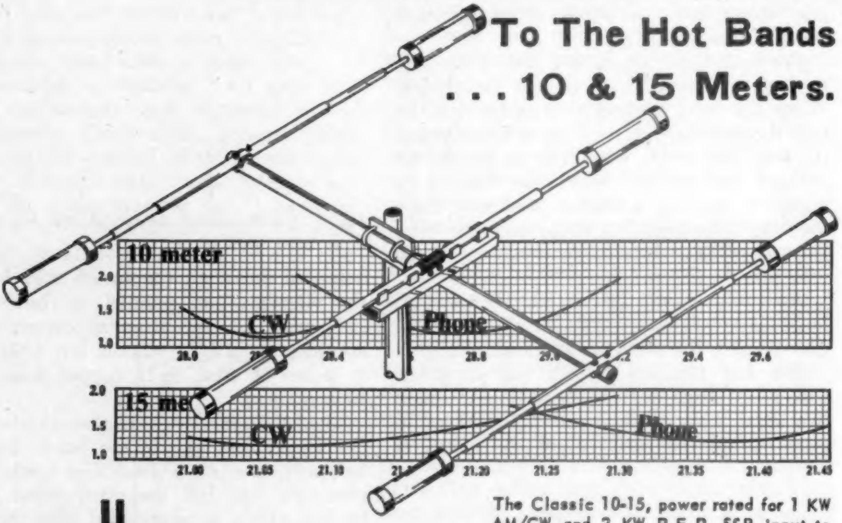

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Richard Lehrbaum WA2APT
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The Miniquad

The Miniquad has two unusual features. 1) It is of all-metal construction[1], thus eliminating the problems of treating bamboo and welding spiders, only to have the whole antenna come tumbling down in a year or two, and 2) It is miniaturized[2], taking up less than *half* the space of a normal two-element quad. Added features of the Miniquad are its low cost, extremely light weight, and general ease of construction. The Miniquad can be built from parts of an old beam, or it can be fabricated from scrap aluminum. It is light enough to be turned by a low-priced TV rotator.

Theory

The antenna illustrated in **Fig. 1** is essentially a two-element quad with .12 wavelength spacing. Note that the two loops are insulated from the booms and thus from each other. The horizontal dimension is .25λ, while the vertical dimension has been reduced from the usual .25λ to .125λ. The difference is made up with loading coils at the bottom of each of the two loops. The Miniquad is thus *rectangular,* rather than cubical, in configuration. The 52-ohm transmission line is inductively coupled to the loading coil on the driven element.

Construction

The Miniquad lends itself to much flexibility in construction. The original version was built at almost zero cost from the parts of an old Telrex beam. However, eight ten-foot sections of tubing of almost any mater-

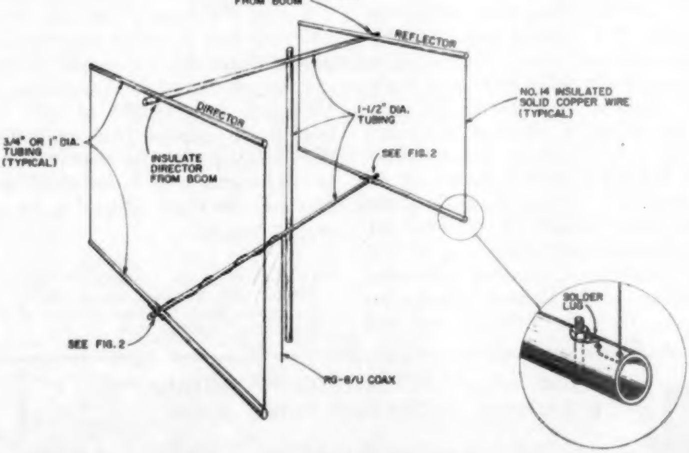
INSULATE REFLECTOR FROM BOOM
REFLECTOR
DIRECTOR
NO. 14 INSULATED SOLID COPPER WIRE (TYPICAL)
1-1/2" DIA. TUBING
3/4" OR 1" DIA. TUBING (TYPICAL)
INSULATE DIRECTOR FROM BOOM
SEE FIG. 2
SEE FIG. 2
RG-8/U COAX
SOLDER LUG

Fig. 1. Construction of the miniquad. For operation at 14250 kHz, element spacing is 100 inches, the horizontal supports are 208 inches long and the vertical distrance between the horizontal supports is 104 inches. The upper supports are insulated from the boom with standoff insulators.

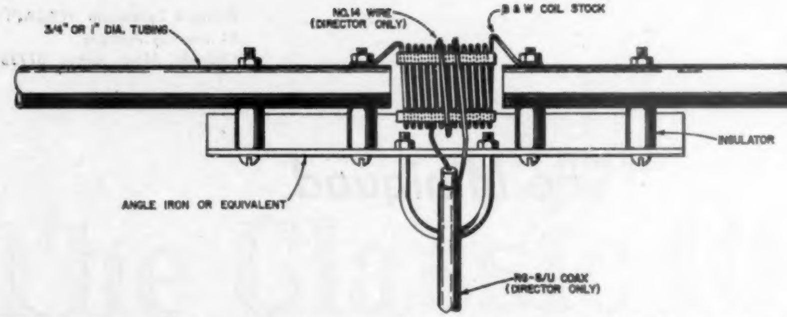

Fig. 2. Loading coil for the miniquad: a piece of coil stock two inches in diameter and three inches long is about right. The feedline is coupled into the antenna with a two or three turn loop around the loading coil.

ial and any diameter provide elements. Center mounts can be constructed of aluminum angle irons with standoffs as insulators. Masts and booms are made of TV masting. Standard antenna hardware is used for mounting the booms to the mast.

The vertical portions of each loop are of insulated number 14 solid copper wire, of the type commonly used in electrical housewiring. The wires may be attached to the ends of the horizontal elements by any convenient means. The wires should be tightened so that the top and bottom elements "bow" slightly toward each other.

Coils

The exact number of turns for the two loading coils and the coupling link depends on many factors and therefore differs for each Miniquad. The original twenty meter Miniquad has coils each made of about three inches of two-inch-diameter B&W coil stock. The driven element coil should be grid-dipped for the center of the desired operating band. Be sure to make this measurement in the absence of stray inductances.

The reflector coil is adjusted, in the usual manner, for either maximum front-to-back ratio or best forward gain. Note that no tuning stub is required on the parasitic element of the Miniquad, as the element already has a loading coil. Thus the reflector coil will simply have somewhat more inductance than that of the driven element.

The 52 ohm coax is coupled to the driven element by winding about five turns of insulated #14 solid copper wire around the loading coil. Since only this link is across the transmission line, a very low standing wave ratio may be obtained by proper choice of the number of turns.

Performance

The SWR of the twenty meter Miniquad used at WA2APT is less than 1.5:1 for the entire band, and close to 1:1 over much of the band. Transmitter output tuning is quite broad, with retuning required only for large frequency changes. Front-to-back and front-to-side ratios seem quite satisfactory.

Using 150 watts input on twenty meter CW and SSB, over 40 countries on all continents have been worked in just a few months of occasional operating, using the Miniquad at a height of only twenty-five feet above ground. All qualitative indications suggest that the Miniquad comes close in performance to a full-sized quad. Who says you can't get something for nothing?

. . . WA2APT

Footnotes

[1] "All-Metal Quad for 15 Meters", Edwin Fehrenbach, KZ5EG, *QST Magazine*, March, 1961.

[2] "The Short Quad," Walter Pinner, WA8BHP, *QST Magazine*, February, 1964.

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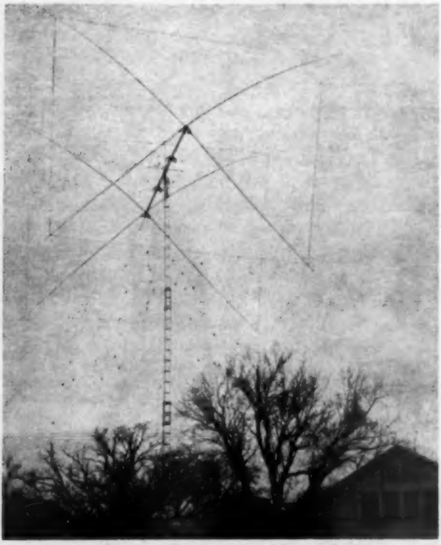
David Morgan K6DDO/W9AIW
4747 Ambrose
Hollywood, California 90027

A Full Size 7 MHz Rotary Cubical Quad

Have you been on 40 recently? Did you notice how much harder it is to consistently work DX with a moderate antenna? Here is the solution to your problem, but you must have the time, patience, cash, a large backyard and no neighbors! Although this antenna was erected way out in the country on a farm in southern Wisconsin, it has attracted considerable attention. The permanent residents of the farm have been continually asked about it and passing airplanes occasionally drop down for a closer look. The volume of this antenna is *only* about 36,750 cubic feet, but that is enough to capture lots of DX! Compare the size of this antenna with the shed in the picture. This is not the first 7 MHz cubical quad, but it is one of the very few in existence; K6PRU used one several years ago and recently W8BAR put one up.



The full sized forty meter cubical quad. Compare its size with the barn in the lower right hand corner.

If one takes a simple half wave folded dipole antenna (0 dB gain), stretches it into a square or rectangle in a horizontal plane, and feeds it at an appropriate place, 3 to 6 dB gain can be obtained (**Fig. 1a** and **1b**). This is similar to taking a 2 element parasitic beam and bending the elements 90° at a point ¼ of their own length back from each end and joining them (**Fig. 1c, 1d** and **1e**).

If two identical antennas are properly spaced, 3 dB additional gain can be obtained; theoretically, this arrary has 6 to 9 dB gain. Suppose, however, for convenience in feeding the elements of **Fig. 2A** (**a** and **c** *and* **b** and **d**) are not connected mechanically as in Fig. 1e but are connected inductively and capacitively. Also, instead of connecting the two feedlines to **a** and **b** together, omit one feedline and connect **a** and **b** mechanically by moving the bent tips into a vertical position. Assume that the same degree of coupling can be obtained regardless of the type, mechanical or inductive. *Do* the same with **c** and **d**; the result is shown in Fig. 2C, the standard cubical quad. It can be seen that the radiating portions of the antenna have not been moved nor their length changed; only the method of feed has been changed. Thus, the gain should remain the same, about 6 to 9 dB.

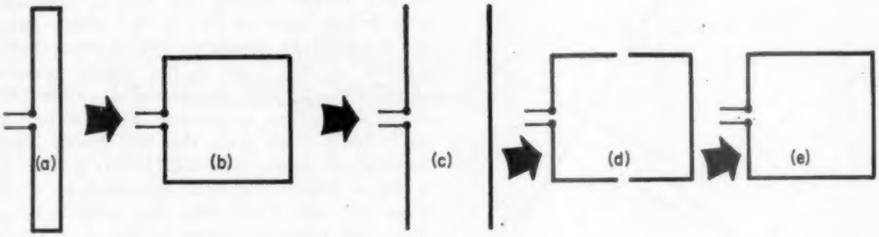


Figure 1

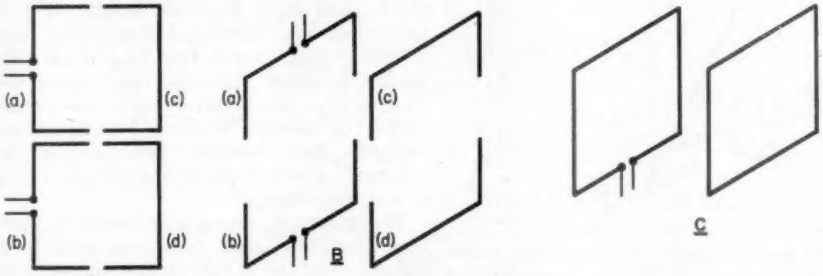


Figure 2

Development of the cubical quad from the folded dipole in Figure 1 and into the two element quad in Figure 2. This development is completely explained in the text.

A full size 7 MHz quad requires supports for two squares of wire that are about 40 feet on a side and spaced 30 feet apart. A structure of several tons could conceivably be used to support these two loops of wire but a more practical way is to build a rotatable support system of minimum weight, bulk, and cost that will withstand wind, bird and ice loading.

Although I used a rather small 55 foot crank up tower, something heavier is advisable. The mast is a six foot length of 1¼" solid steel shaft; a surplus motor system with a gearbox and selsyn are mounted at the base of the shaft. The shaft is coupled to the motor through a slotted section of pipe mounted on the rotor. Right angle gears connect the shaft to a Rotobrake* mounted on the side of the tower. A greased sleeve mounted in the top of the Tri-Ex tower acts as a thrust bearing. Just above the top of the tower a 24" x 12" x ¼" steel plate is mounted on the 1¼" shaft by means of four U bolt muffler clamps as shown in the photographs. On the back of this plate four home made 4" U-bolts made from ⅜" Redirod were installed. The 30' x 4" OD 0.06" wall aluminum boom is supported at its center by these four clamps. A sleeve of inner tube rubber around the boom restricts slippage of the boom during wind vibration and a semicircular sleeve of aluminum sheet on the outside of the rubber (on the clampside) prevents tight clamps from kinking the boom. A heavy ground strap grounds the boom to the tower and to a ground post. A bolt through the boom could have been used to prevent boom rotation but there was some possibility that this might weaken it at a critical point.

Additional boom support is provided by the boom guy system. A second steel plate is clamped on the mast just above the boom support plate (Fig. 4). A piece of pipe is clamped on the backside of this plate and holes were drilled at the ends to accommodate screw eyes. Guy wires of galvanized #9 wire run from these screw eyes to the boom tips where they are anchored with irrigation tubing clamps. These four guys hold the boom firmly in the horizontal plane.

Since the 6' steel shaft was too short, an extension of 1¾" OD water pipe, 6' long was mounted on top of it with two

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* Hq-Gain Antenna Products Corp., N.E. Highway 6 at Stevens Creek, Lincoln, Nebraska 68501.

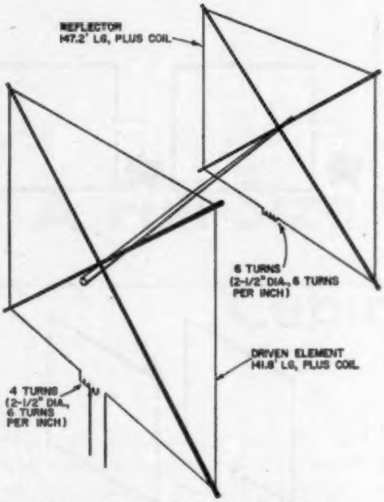


Fig. 2. The full size forty meter quad.

bolts going all the way through both sections. To prevent boom sag, guy wires were connected between screw eyes mounted on top of the mast and the ends of the boom; turnbuckles permitted adjustment for minimum sag. The complete assembly is well balanced and spins on the ball bearing mount with the twitch of a finger.

Many spider systems were considered, but the one finally adopted was developed from a suggestion of Roger Mace, W6RW. A piece of 24" x 12" x ⅛" (10 gauge) steel plate was bent 90° at the center. A piece of 4" ID water pipe was sliced into 1" wide rings; each of these was slit along one side. Two of these were welded to each plate as shown in **Fig. 4.**

On each side of the slits in these clamps an over-size nut was welded; a bolt could be run through these nuts to tighten the clamp snugly around the boom. Diagonal reinforcing bars of 1" x ¼" steel strap were added as shown in Fig. 4. Two holes drilled at the base of the plate accomodate U-bolts; a 3" length of 1" wide, ¼" thick angle iron is welded into the top of each plate flush with the 90° bend. Each section of angle iron has holes drilled in it for a U-bolt and was mounted so as to have one side flush with the other side of the angle plate as shown in Fig. 4. A thirty foot piece of 2" OD aluminum irrigation tubing was used for the central section of the support arms. Five-foot lengths of 1⅞" OD tubes are telescoped inside the ends of this piece. Twelve foot lengths of high quality bamboo* are telescoped inside the ends of the aluminum to give an overall length of about 56 feet. For maximum strength these bamboo poles should be wrapped with a layer of surgical gauze and coated with fiberglass.

Method of supporting the boom to the mast. This photo also shows part of the guy wire system used.

The tubing to tubing and tubing to bamboo joints are made as shown in Fig. 4. Sleeves of sheet aluminum are placed over the arms where theU-bolts will grip them. Good quality hose clamps may be obtained from an automotive supply house for the joints. About 6 inches from the upper tip of each piece of bamboo the wood should be wrapped with tape, a hole drilled and a small pulley tied on. These two pulleys support the upper corners of the wire square and permit it to be lowered for adjustments; nylon cord is used in the pulleys.

In order to prevent the spider arms from breaking in the wind they must be properly guyed. Holes were drilled in the two 1" straps welded across the bottom of the spider plates and at the tips of two 5 foot pieces of ¾" pipe; these pipes were bolted on as boom extensions. Nylon parachute cords run from the holes in the end of each boom extension to the tips of each of the four element arms. Three separate strands should be used in parallel for maximum protection. Likewise, four guys run from the other side of the element arms to an extra spider on the inner side of the boom (reserved for future additions). For further support of the arms, particularly when the wire square is lowered, nylon rope was run in a square around the bamboo arms 6 feet from their tips; the total arm guy system is shown in Fig. 5.

*Good quality bamboo will be shipped by the Sea and Jungle Shop, 4666 San Fernando Road, Glendale, California. They maintain a large stock of all sizes.

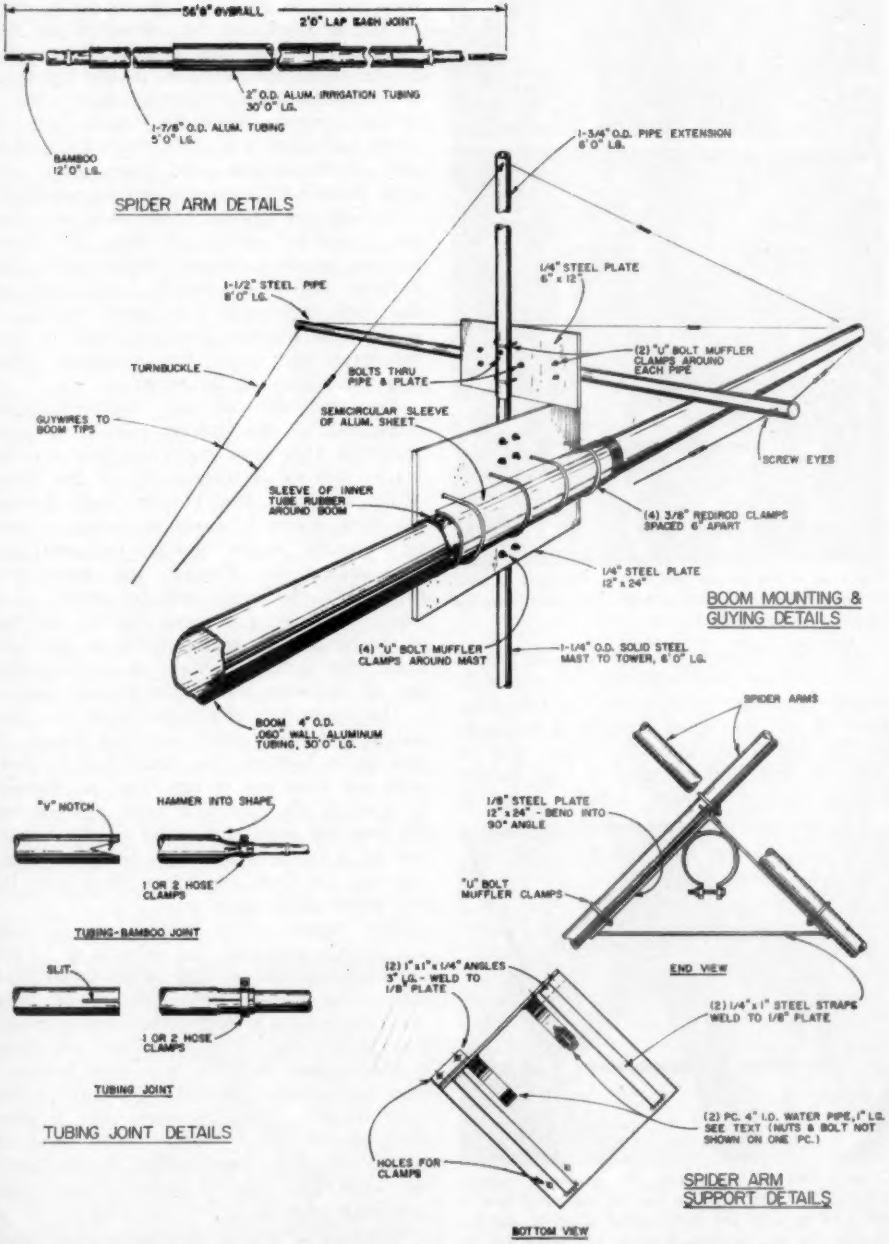
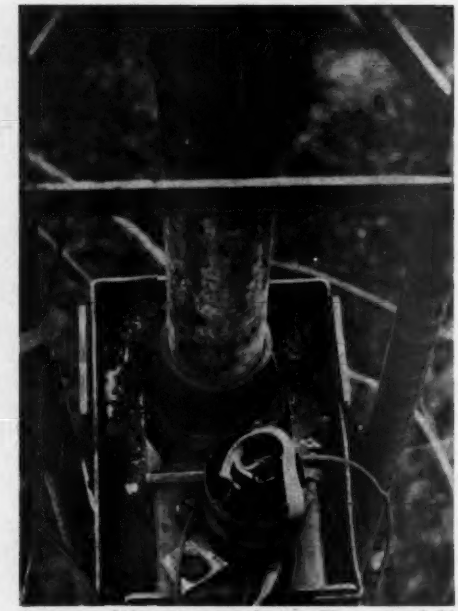
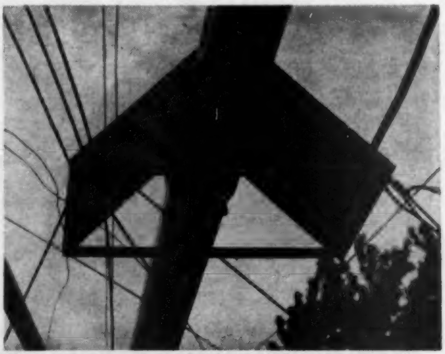

56'8" OVERALL
2'0" LAP EACH JOINT
2" O.D. ALUM. IRRIGATION TUBING
30'0" LG.
1-7/8" O.D. ALUM. TUBING
5'0" LG.
BAMBOO
12'0" LG.
SPIDER ARM DETAILS
1-3/4" O.D. PIPE EXTENSION
6'0" LG.
1-1/2" STEEL PIPE
8'0" LG.
1/4" STEEL PLATE
6" x 12"
TURNBUCKLE
BOLTS THRU
PIPE & PLATE
(2) "U" BOLT MUFFLER
CLAMPS AROUND
EACH PIPE
GUYWIRES TO
BOOM TIPS
SEMICIRCULAR SLEEVE
OF ALUM. SHEET
SCREW EYES
SLEEVE OF INNER
TUBE RUBBER
AROUND BOOM
(4) 3/8" REDIROD CLAMPS
SPACED 6" APART
1/4" STEEL PLATE
12" x 24"
BOOM MOUNTING &
GUYING DETAILS
(4) "U" BOLT MUFFLER
CLAMPS AROUND MAST
1-1/4" O.D. SOLID STEEL
MAST TO TOWER, 6'0" LG.
BOOM 4" O.D.
.060" WALL ALUMINUM
TUBING, 30'0" LG.
SPIDER ARMS
"V" NOTCH
HAMMER INTO SHAPE
1 OR 2 HOSE
CLAMPS
TUBING-BAMBOO JOINT
SLIT
1 OR 2 HOSE
CLAMPS
TUBING JOINT
TUBING JOINT DETAILS
1/8" STEEL PLATE
12" x 24" - BEND INTO
90° ANGLE
"U" BOLT
MUFFLER CLAMPS
END VIEW
(2) 1" x 1" x 1/4" ANGLES
3" LG. - WELD TO
1/8" PLATE
(2) 1/4" x 1" STEEL STRAPS
WELD TO 1/8" PLATE
(2) PC. 4" I.D. WATER PIPE, 1" LG.
SEE TEXT (NUTS & BOLT NOT
SHOWN ON ONE PC.)
HOLES FOR
CLAMPS
SPIDER ARM
SUPPORT DETAILS
BOTTOM VIEW

Fig. 4. Construction details of the forty meter cubical quad. This type of construction results in a light weight assembly that will withstand wind loading up to 60 mph.



Top view of the rotator mechanism. The mast is held in the slotted collar with a bolt. The selsyn may be seen in the foreground.

Assembly requires strategy but this leaves room for your own ingenuity. If you're in a hurry you may want to try the following. First of all, you need something to stand on 15 feet away from the tower and at least 20 feet high. I used a long ladder leaning against a truck, heavily guyed in each direction. A large pulley is placed on top of the mast to haul up parts. Most of the antenna can be assembled by one person but two people make it a lot simpler.



Closeup view of the spiders; this spider is midway between the mast and the end of the boom and is not used to hold the forty meter quad. It was intended for the additional of a full sized twenty meter quad at a later date. In the forty meter quad it serves as an anchor point for part of the guy wire system.

The items are mounted in the following order: rotor, ball bearing, gears, thrust bearing, mast, Rotobrake, boom support plate, and boom guy plate. Then the spiders, guy extension arms, and boom guys with extra lengths of cord attached for manipulation from the ground. The boom is raised into place by pulley and then tied down to hang beside the boom support plate. The U-bolts, sleeves and rubber are added and the bolts tightened. The extra lengths of cord on the boom guys are used to pull the guys into place for anchoring; then they are temporarily tightened.

The four element arms are completely fabricated on the ground and their guys attached. One man can carry one up the ladder and tie it temporarily to the boom while adjusting the U-bolts and sleeves. However, it may be more convenient to have an assistant on the ground to hand you one side of the element arm while you manipulate the other side by means of a rope (don't use guy ropes tied to the tips of the bamboo for manipulation or you may break the bamboo). Make sure the pulley tips of the arms are on the ground side.

The other ends of the guy ropes are now fastened. At this point only the square of guy ropes between the individual bamboo arms will have one or two ropes unfastened 35 feet in the air. The extra spiders are 7.5 feet out from the center of the tower, but by wearing a lineman's belt and leaning way out from the tower, they may be reached to tie the guys on.

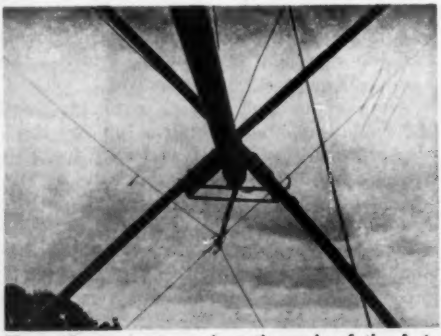
The second set of spider arms is now added. If convenient, the boom may be rotated around to put the other boom end above your ladder; the second set of arms and guys is then added in the same manner. The pulley tips of the bamboo are close to the ground and the guy rope between them is securely fastened. This guy carries more weight than the others and if possible, should be of heavier nylon rope. It should always be kept tight as it distributes the wind load more equally between the four diagonal arms.

When these guys have been adjusted and the other guys have been added to the pulley arms, the 4 boom U-bolts are loosened and the boom is rotated 180° on its own axis to put the pulley tips high in the air (if you have a derrick truck you can work on each part of the antenna without the need for boom rotation). The remaining guys are then fastened. The wire elements are prefabricated on the ground and may be pulled up with the pulley ropes and tied down. In my case it was found convenient to hang a nylon rope from the boom tip to support the heavy gamma match and RG-8/U coaxial feedline.

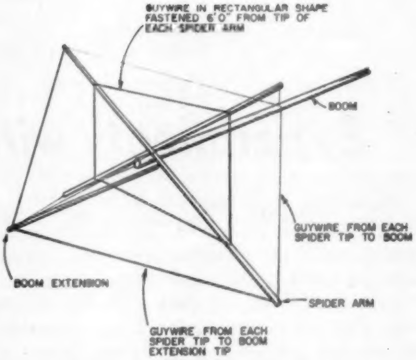
Considerable adjusting and tinkering was done with the elements after the antenna was mounted on the tower. The final dimensions include a coil at the bottom center of each element for length adjustments. Little efficiency is sacrificed by using coils and they are much more convenient than changing large lengths of wire. The dimensions of the elements are given in Table 1.

The resonant frequency was 7.0 MHz when the boom was 25 feet off the ground; at 56 feet the resonant frequency was 7.2 MHz with the following SWR across the land: 7000 kHz, 1.8; 7100 kHz, 1.4; 7200 kHz, 1.25; and 7300 kHz, 1.4. The resonant frequency shifted about 50 kHz during rotation due to proximity of nearby objects, but this was of little consequence because of the broadbanded nature of this quad. The gamma match uses two #12 wires 4.6 feet long and spaced 6 inches apart with plastic spacers; a series 200 pF capacitor was used to tune out the inductive reactance of the gamma match.

This quad gave very good results in the 1961 World Wide DX contest and 1962 ARRL DX contest. Africa was worked via long path and European hams were heard on the long path around 1400 GMT; DX worked included HV1CN, FB8XX, TU2AL, VK5XK/VK9, EP2BQ, VS9AAC, and ST2AR. The quad compared very favorably with full size two element beams of similar height in the USA but no local beams were available for comparison. JA's were worked one after another in the morning and stations running 5 to 20 watts from several continents had good 559 and 569 signals; Europeans have been as strong as 40 db over 9 on a 75A4. The quad consistently got very good signal reports and often, "First W9 on 7 MHz".



The spider supports used at the ends of the forty meter cubical quad.



GUYWIRE IN RECTANGULAR SHAPE FASTENED 6'0" FROM TIP OF EACH SPIDER ARM
BOOM
GUYWIRE FROM EACH SPIDER TIP TO BOOM
BOOM EXTENSION
SPIDER ARM
GUYWIRE FROM EACH SPIDER TIP TO BOOM EXTENSION TIP

Fig. 5 Guying system used with the spider arms. Without this system the arms will break in winds of 30 to 40 mph.

The front to back ratio runs from 5 to 40 db depending on the direction, angle of radiation and skip characteristics. Numerous observations of 7 MHz broadcast stations and hams showed average gains of two S-units or better over a 1000 foot longwire aimed at Europe. Nearly all work has been on CW with 900 watts, but with a borrowed SSB exciter all continents except Asia were easily worked.

The antenna has stood up well in 50 to 60 mph winds, snow, and ice as long as all guys were kept tight; if the guys are not tight the arms will break in winds of 30 to 40 mph. This antenna is a joy to operate with on 40 meters, but you must take a bit of time to build and maintain it.

I wish to express my appreciation particularly to my tolerant landlady, Mrs. Ellen Richardson, to Alice and Otis Onsrud (Mr. Onsrud contributed the expert welding), Tom Leffingwell, and Donald Weinshank. Also to W4VRD, W6RW, K9ELT, K9KNC, W9SZR, and to all the others who have helped.

. . . K6DDO

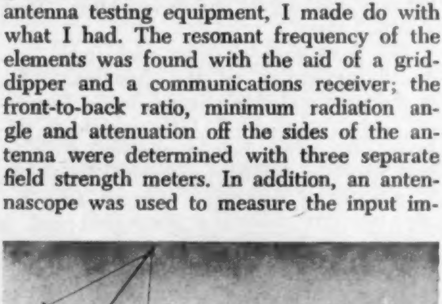
Ratti Lanfranco I1RR
via Friuli 28
Milano, Italy

Experiments with Quad Antennas

Over the past few years I have constructed a number of antennas, largely based on data collected from the various ham magazines. In most cases however, I wasn't completely satisfied with the results; also, the dimensions varied from one article to another and the gain figures given by the authors seemed to be somewhat excessive.

I decided that the only way I was going to get a proper answer was to conduct a little basic research. With the few instruments that I have at my disposal, and a lot of cut and try, I think I can now provide some useful information on the construction of cubical quad antennas.

My first experimental quad antenna was designed for 145 MHz. This antenna was designed in such a way that I could vary the dimensions, spacing and height from the ground. Since I didn't have a lot of exotic antenna testing equipment, I made do with what I had. The resonant frequency of the elements was found with the aid of a grid-dipper and a communications receiver; the front-to-back ratio, minimum radiation angle and attenuation off the sides of the antenna were determined with three separate field strength meters. In addition, an antennascope was used to measure the input impedance to the quad and an SWR meter used to check the match.



The six element quad for two meters is centered on 145 MHz. This antenna has a boom length of 144.5 inches, just a hair over twelve feet, and has provided excellent results on two meters.

With this simple test equipment I closely examined a three element quad for two meters and the effects of element spacing, height above ground and various elements dimensions. To insure that the results were not just casual but repititive, the tests were conducted over a three month period and have been repeated three times; in each case the entire antenna was completely disassembled and re-assembled. After I had completed all the tests on the 145 MHz quad, I used the experimental data to develop a three element three band quad for 14, 21 and 28 MHz.

Obviously, to construct an antenna for three different bands, I had to make compromises to obtain optimum results on all three bands. During the course of my experimentation I was able to establish that when a reflector was adjusted by means of a stub on the lower part of the square, the antenna became asymmetric and lost considerable gain in the horizontal plane. Therefore, two stubs should be used to adjust the reflector and other parasitic elements; one on the upper side of the reflector and one on the lower side. In addition, these two stubs should be adjusted together. This solution practically precludes adjusting an antenna for 14, 21 and 28 MHz, so I completely removed the stubs and made all the sides of the quad perfectly symmetrical. I also found in the course of my experiments that the alignment between the wires of the various elements is very important.

After completing the experiments with the model antennas, I built a full size three element quad for 14, 21 and 28 Mhz. This antenna has been placed on a support projecting 5 meters (about 16½ feet) from the roof of my house. This antenna is fed with a single transmission line; two relays mounted in a water-tight box switch in the proper radiator when I change bands. It is highly advisable to use a ¼ wavelength of transmission line (or an odd multiple) between the relay switch box and the radia-

Quad Dimensions

Total Length of Wire used in each element

Band	10 Meters	15 Meters	20 Meters	2 Meters
Reflector	1079 cm (424.8 in)	1470 cm (578.7 in)	2204 cm (867.7 in)	216 cm (85.0 in)
Radiator	1029 cm (405.1 in)	1403 cm (552.4 in)	2103 cm (828.0 in)	206 cm (81.1 in)
Director	978 cm (385.0 in)	1333 cm (524.8 in)	1997 cm (786.2 in)	197 cm (77.6 in)

Spacing between elements: on the tri-band beam for 10, 15 and 19, and 20, the director is spaced 260 cm (102.4 in) from the radiator; the reflector is spaced 230 cm (90.6 in) from the radiator. For the six element two meter quad all spacings are in reference to the radiator and are as follows: reflector, 31 cm (12.2 in); 1st director, 29 cm (11.4 in); 2nd director, 63 cm (24.8 in); 3rd director, 96 cm (37.8 in); and 4th director, 148 cm (58.3 in).

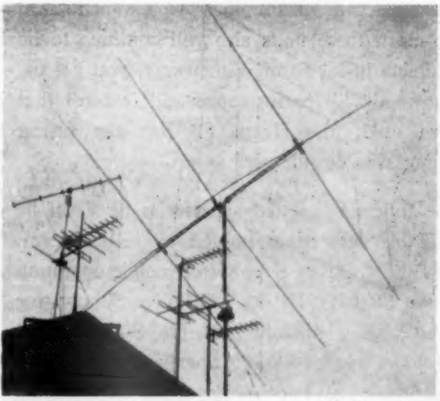
tor element. You definitely should *not* tie the three radiator squares together to facilitate feeding by a single transmission line; the gain and directivity are completely destroyed.

Mechanically the beam was constructed by using a boom of extra-light steel tubing on which three cast aluminum cross-pieces are threaded. Bamboo poles were used to support the wires. At the points where the wire squares are fixed, stainless steel springs have been mounted to keep the wires taut and in alignment without subjecting the bamboo supports to flexing. These springs also compensate for the lack of symmetry of the poles after they are mounted on the boom. After the wires and stainless steel springs were mounted, all the bamboo poles were given a coat of protective paint.

Where the poles are attached to the cross-arms, a small sheet of thin rubber 6 mm thick (about ¼ inch) has been inserted to make the joint more elastic. The poles are then fixed in place with galvanized U-bolts. The preparation of the wire squares requires the utmost in accuracy; the data shown in the following tables should be followed as closely as possible. The easiest way to accomplish this is to unwind the wire, measure a length 20 cm long (8 inches), form a small eyelet in the wire and solder it so it provides a reference point for the subsequent eyelet. Each side of the square is carefully measured until the whole square has been made; the first length of wire is used to close the last side with a solder joint. Close attention to this procedure greatly facilitates the final assembly, and permits easy installation of the eyelets at the corners over the stainless steel springs. The same method may be used for the construction of a 144 MHz quad, but for the two meter version the bamboo should be replaced with a material that has better rf characteristics.

The results obtained with this antenna are best illustrated by comparing it to a multiband commercial unit. The front-to-back ratio is not maximized because of the compromises made in dimensions to permit optimum operation on three bands. However, on 20 meters the front-to-back ratio is on the order of 22 dB. The vertical angle of radiation appears to be lower than that of a two element quad, but unfortunately, comparative tests are difficult to evaluate in terms of radiation angle and front-to-side ratios. The actual operating results have been excellent; with only 16 watts input on 14, 21 and 28 MHz, I have had excellent results working DX stations.

I have also been extremely pleased with the results obtained with the six element two meter quad; this antenna has consistently out-performed large commercial antennas installed by local amateurs.



The three element quad for 10, 15 and 20 meters. The SWR on all bands is less than 1.5:1, even at the band edges. On 14.00 and 14.35 MHz for example, the SWR is 1.4:1, at 14.18 MHz it is 1.2:1; at 21.00 and 21.45, the SWR is 1.2:1, at 21.23 it is 1.1:1; and on 28.2 and 29.5 the SWR is 1.4:1, at 28.8 it is 1.2:1. SWR checks with both Heathkit and Jones Micromatch bridges provided almost identical results.

. . . I1RR

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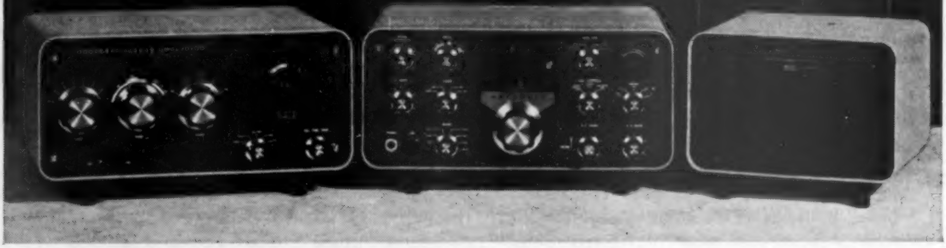

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• Supplies voltages for SB-101 • Excellent dynamic regulation • Fused primary • Can be installed inside SB-600 speaker cab.

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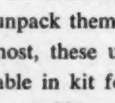

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The Half Quad Antenna

A muscular version of the inverted V dipole

Thirty some odd years ago, E. J. Sterba developed a form of stacked dipole antenna which bears his name. Although the Sterba curtain is not too popular with radio amateurs, it is, none the less, an excellent antenna. The Sterba, as you no doubt know, is the grandaddy of some antennas that enjoy great popularity today.

The lazy H, a simplified version of the Sterba in its basic form, is one of the descendants of the Sterba, and was introduced to the amateur world by W6BCX. From the lazy H, the same gentleman, W6BCX, developed the bi-square by combining the half wave elements in the form of a square. The bi-square dimensions, particularly at the lower frequencies, become rather ungainly mechanically, so it was inevitable that someone would find a way to reduce the size of the half wave sides and still retain reasonably good gain. We know this reduced size bi-square, with one quarter wave length sides, as the cubical quad. Now, let's take the quad and reduce it in size by slicing it in two, leaving only the top half. This remaining half, for want of a better name, becomes a half quad.

The main advantage of the half quad is that it can be erected for the 40 and 80 meter bands without resorting to the use of broadcast station size towers. The half quad employs wire elements, supported in

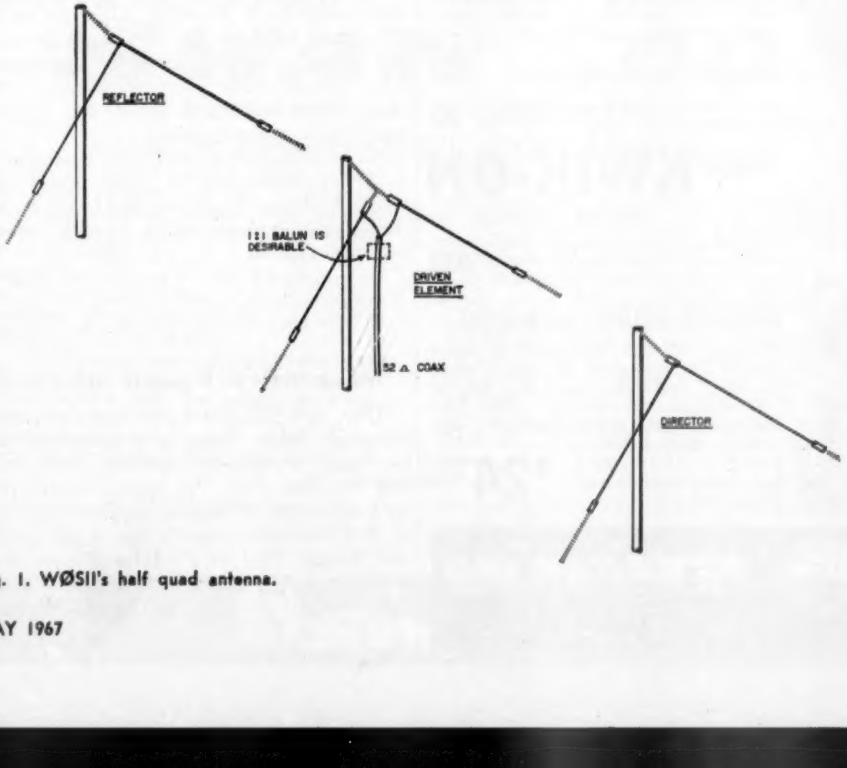

Fig. 1. WØSII's half quad antenna.

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Oceanside, California

Half Quad Dimension

Half Quad Dimension

	7.1 MHz	7.2 MHz	3.8 MHz	3.9 MHz
Reflector	69'10"	68'3"	129'2"	126'
Driven Element	66'	65'	123'	120'
Director	62'8"	61'3"	106'10"	114'

One quarter wave length, for element spacing, (In Feet) = $\frac{246}{\text{Freq (MHz)}}$

the center with a single pole. The elements are slanted down toward ground at an angle of approximateliy 45 degrees (See **Fig. 1**). The parasitic elements are attached to the poles with small insulators, and the driven element is constructed and attached to its pole in the normal inverted "V" fashion.

The two or three element version of the half quad, with one quarter wave spacing between elements, will give good gain and allow the array to be fed directly with 52 ohm coax cable. With one quarter wave length spacing, the feed impedance of the half quad, using the two element version with a driven element and reflector, will be about 60 ohms. The three element half quad will give a feed point impedance of approximately 30 ohms. The gain of two element half quad is 4.5 dB, and for the three element half quad, 8 dB.

The half quad at this QTH is the 40 meter size, suspended from 50 foot poles, and oriented on Australia. The reports on SSB, received from the VK's, range from S-5 to S-8, a very respectable performance from a horizontally polarized antenna with an average height of about one quarter wave length above ground.

As an added note, and with apologies to an old acquaintance Dr. John Kraus, the W8JK Flat-Top array can be rigged in the Half Quad manner, when a bi-directional pattern is desired.

. . . WØSII

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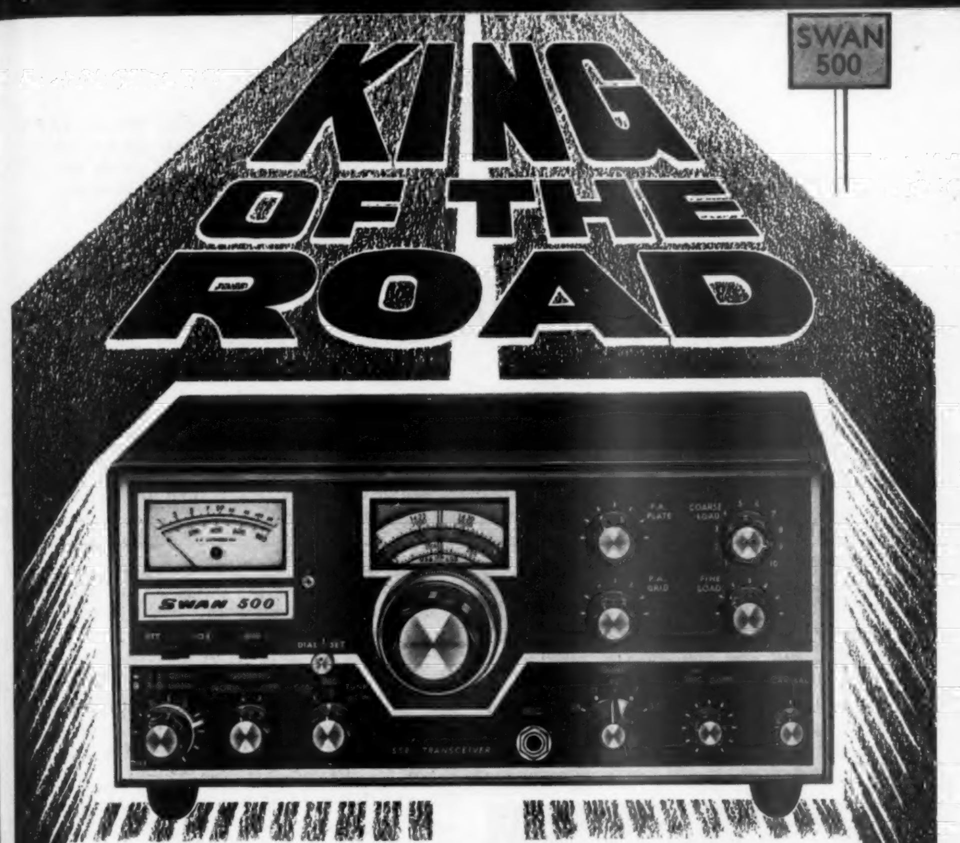
. . . Edwin Hill W3URE



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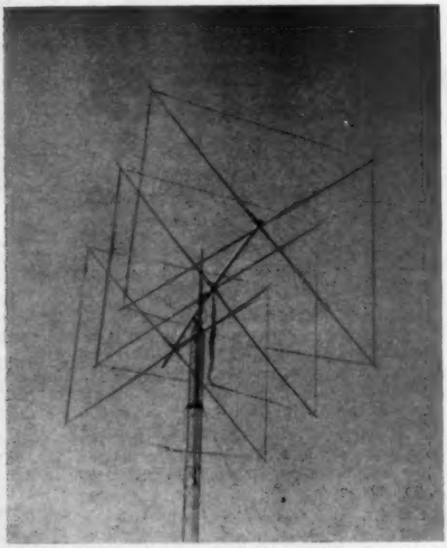
The Three Element Quad

It is certainly not an "old wive's tale" when someone speaks about the performance results of the two element cubical quad. The gain is comparable to that of a three element yagi. From personal experience, the front-to-back ratio ranges from 25 to 30 dB, with the front-to-side ratio reaching as much as 40 dB. For the size of the antenna it packs a mighty punch in the roughest of pile-ups, and amateurs around the world will attest to its performance. Another favorable aspect of the quad is the relatively low construction cost.



The three element quad as seen from K8YIB's house shows the director, the driven element, and the reflector. The boom consists of three inch irrigation tubing and the spreaders are bamboo.

As we all know, most amateurs are never satisfied with their antenna, so we decided to go one better, and try a three element quad. There was very little information available on this type of antenna, nevertheless the problem of design and construction was undertaken.

Design

The dimensions for the three element quad were taken from W0AIW's dimensions for his four element quad. It was thought that we had to start somewhere, and Lee's figures looked good. Originally the boom length was twenty-five feet, but after running some tests on the air with local and out-of-state stations, it was decided that the front-to-back ratio was suffering badly. Thanks go to WA0IOR, Hal, whose suggestion to shorten the boom length was a great help in the final success of the antenna.

Construction

Spreaders: Fiberglass poles make excellent, durable spreaders, but are guite expensive. Bamboo poles also suffice, but do not weather well unless they are protected. A few coats of Spar varnish will last several years, but if the poles are fiberglassed, they will last indefinitely. Fiberglass resin and fiberglass cloth are available at most boat centers and sport shops. The bamboo poles were cut to a length of thirteen feet, and wrapped from the small end to the butt with three inch wide fiberglass cloth. About half a quart of resin was mixed at a time, and applied with a paint brush. About two days are required for the poles to dry.

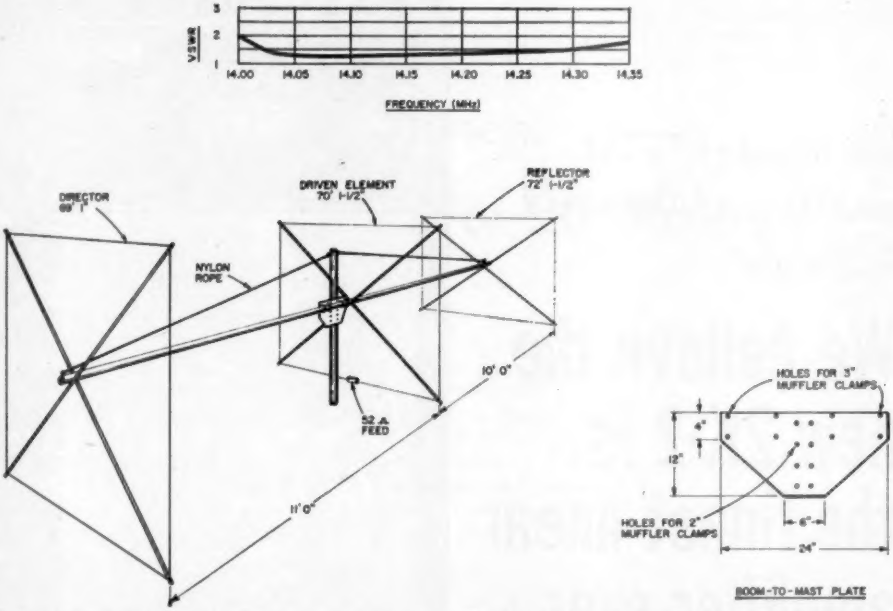

3
2
1
VSWR
14.00
14.05
14.10
14.15
14.20
14.25
14.30
14.35
FREQUENCY (MHz)
DIRECTOR
69' 1"
DRIVEN ELEMENT
70' 1-1/2"
REFLECTOR
72' 1-1/2"
NYLON
ROPE
52 Ω
FEED
10' 0"
11' 0"
HOLES FOR 3"
MUFFLER CLAMPS
4"
12"
HOLES FOR 2"
MUFFLER CLAMPS
6"
24"
BOOM-TO-MAST PLATE

Fig. 1. This three element quad for twenty meters provides extremely wide bandwidth as indicated by the low SWR throughout the band. The construction of this quad is straight-forward and only requires a boom length of 21 feet.

Supporting crossarms: Three foot sections of one inch angle aluminum were used to hold the poles to the boom. The muffler clamps used between the angle stock and the boom are three inch. The bamboo poles are held to the angle aluminum by one and a half inch hose clamps.

Boom: The boom consists of twenty-one feet of three inch irrigation tubing. The spacing from the reflector to the driven element is ten feet, and the distance from the driven element to the director is eleven feet.

The supporting crossarms.

Stringing the elements: Number fourteen wire was stretched out and marked at 69′ 1″ for the director, 70′ 1½″ for the driven element, and 72′1½″ for the reflector. After the crossarms had been assembled, the spreaders were staked out perpendicular to each other, and each element was strung.

Assembly and tuning: Each element was fastened to its respective position on the boom, and 52 ohm cable was attached directly to the driven element. Tuning stubs were fashioned out of #12 wire and fastened to the director and reflector. The antenna was raised to approximately twenty feet, and the stubs were adjusted to give maximum s-meter readings on a receiver beneath the antenna.

Repeated comparisons with a nearby station, on the long and short haul DX, seem to indicate that the three element quad is comparable to his four element yagi. The front-to-back and front-to-side ratios are as good if not better than the two element quad.

Over 200 countries have been worked in the last six months, and good success has been experienced in the pile-ups.

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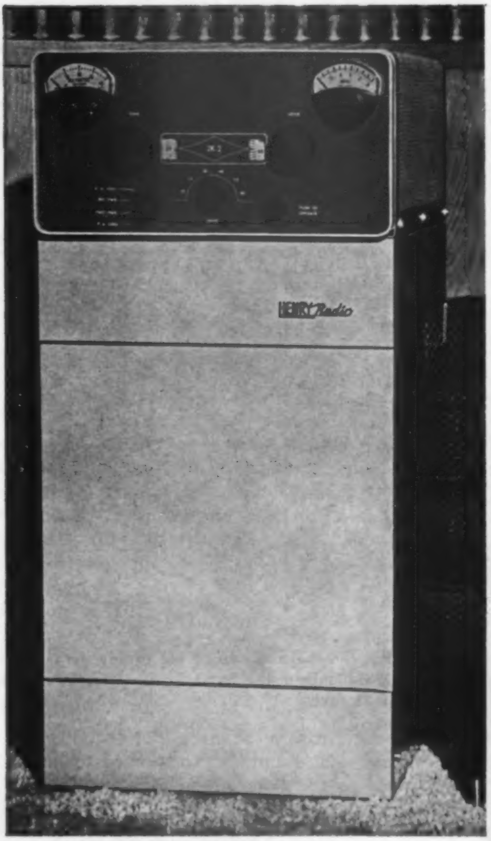

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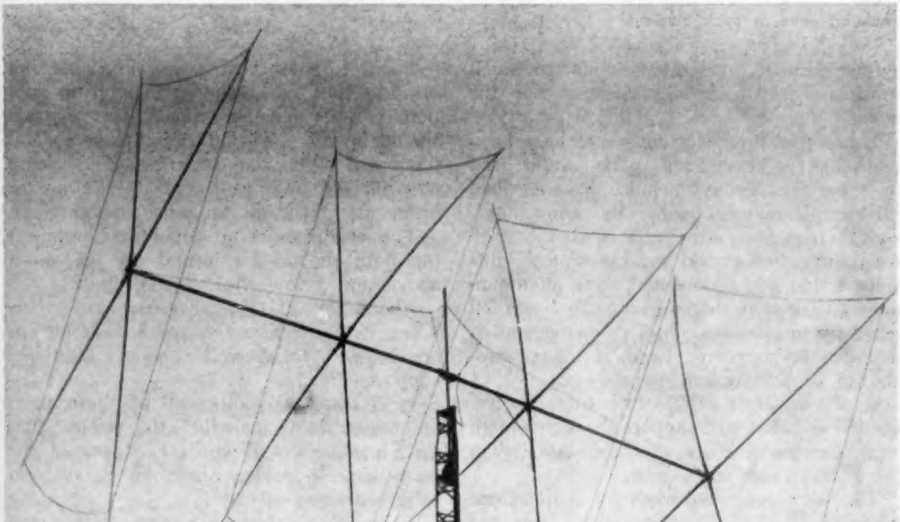
Well it's easier to increase power in the antenna than it is to improve output power in the transmitter.

For example: If one ham in town puts up a quad that gives 10 dB gain, then another ham in the same town would have to increase his output power 10 times to get the same signal report. A 100 watt station using this same antenna would be as strong as his neighbor running 1,000 watts to a dipole.

A recent survey among leading DXers in the world shows that the six element beams and the four element quads put out the "big" signals.

Most people don't have the room or the money to put up a six element beam but



A four element quad for 20 meters. This antenna weighs less than 50 pounds and has withstood winds up to 80 miles per hour.

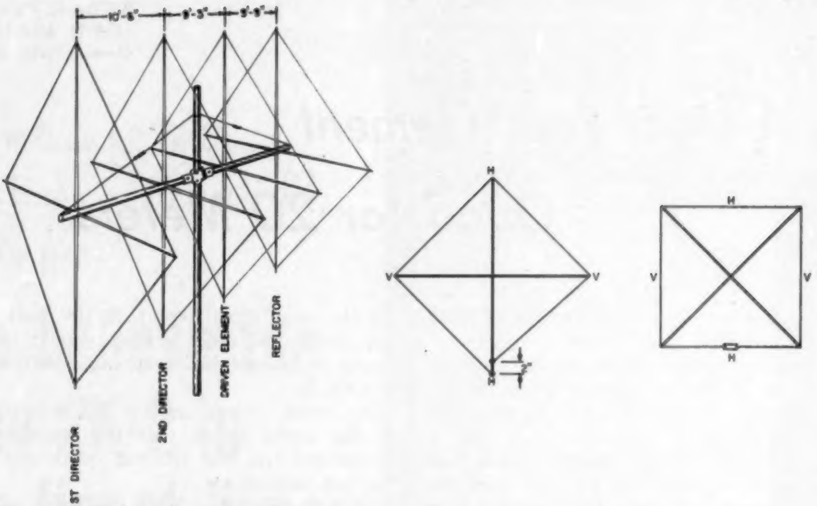


Fig. 1. Overall view of the four element quad for 20 meters; the total boom length is nearly 30 feet. Either diamond or square construction may be used as shown on the right, but the square model requires insulators—one in each element.

a four element quad doesn't take too much space and is considerably cheaper than the beam.

In the past, four element quads have been bulky, very heavy and parts were hard to come by. Today a four element quad can weigh under 50 lbs. By using lightweight fiberglass arms (16 of them) each weighing only a pound and by using a lightweight aluminum boom and using aluminum braces to mount the arms to the boom all totals up to a lightweight four element quad that can be supported by most towers capable of supporting a tri-band beam.

A 2" x 30' x .065 wall tubing spec. 6061ST-6 boom will support the lightweight arms and has a lower wind resistance than the 4" boom used in the past.

The least expensive arms for a quad are made of wood or bamboo. These arms can crack, split, warp and are easily broken during construction or by the wind after construction.

Commercial fiberglass is now available within the price range of the average income. This fiberglass is made especially for quad antennas and is manufactured by several companies. These lightweight arms sell for about $5 each or $80 for the 16 arms.

Quad arm mounts are also available for around $5 each or $20 for the 4 mounts.

Boom to mast clamps are available but be sure that they are big enough to support a four element quad. The support should be 12" x 2" O.D. for the boom and 6" x 1½" O.D. for the mast. The clamp on your old antenna might do the job or order one from an antenna manufacturer.

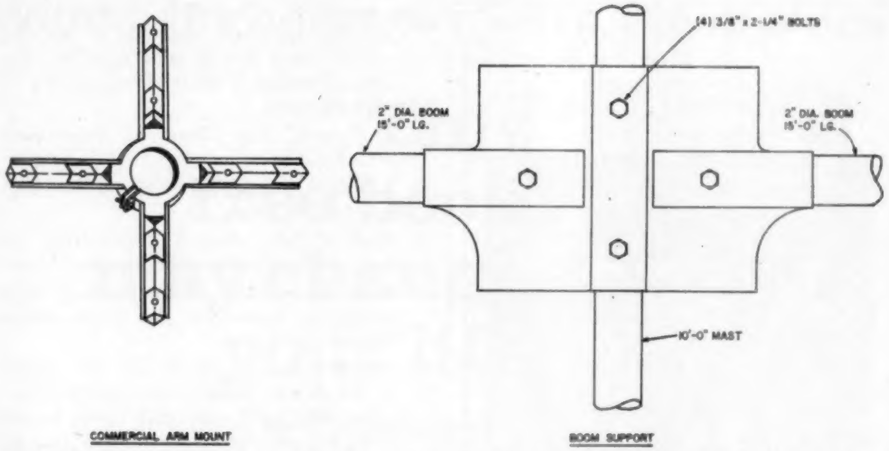
The clamp must be capable of supporting both the 2" boom and the 1½" mast above and below the boom (Fig. 2).

About 50' of ⅛" galvanized guy wire, 2 heavy duty turnbuckles and 8 cable clamps are needed to give the boom additional support (Fig. 1).

Several companies offer all of these parts for under $150 including the boom. This price can be cut if one makes any of the parts himself or has them on hand from other antenna projects.

There is no real difference between a quad shaped like a diamond and one shaped like a square. The important thing is the feedpoint (Fig. 1). Feeding the antenna at any point marked H results in horizontal polarization and feeding at any point marked V will result in vertical polarization.

The most widely used polarization is horizontal. It is easier to tune the antenna and the tower will have less effect on the antenna than if vertical polarization would have been used.



COMMERCIAL ARM MOUNT

BOOM SUPPORT

Fig. 2. The commercial arm mount and boom support used with the four element 20 meter quad. This particular design has withstood winds up to 80 miles per hour.

The diamond quad offers an excellent route for the feedline to be run. The feedline can be taped directly to the fiberglass arm with no ill effects. The square quad requires 4 insulators, one for each element (Fig. 1).

A quad is not an especially broad-banded antenna; the SWR can be tuned to almost 1 to 1 at any one frequency but the SWR rises more rapidly than does the SWR in many beams. This is not a serious drawback as the SWR is under 2 to 1 over most of the band (Fig. 3).

The resonant frequency can be changed easily by lengthening or shortening the wire or by using coils, shorted stubs, tuning stubs or other tuning methods.

The length of the wire on each side of the quad can be calculated by using the formula 248 or the formula 984 for the total length of each loop. The approximate total length of the wire for the 20 meter phone band is:

1st director	66′ 6″
2nd director	68′ 3″
driven element	70′ 0″
reflector	71′ 9″

The above lengths were calculated by increasing the driven element length 2½% for the reflector and by decreasing the directors 2½% from the driven element size.

The radiation resistance of the quad will be close to 50 ohms and the greatest gain will be achieved when the elements are spaced:

1st to 2nd director	10′ 6″
director to driven	9′ 3″
driven to reflector	9′ 9″

This uses all but 6″ of the 30′ boom.

1. Select a flat place in the yard to lay out the quad arms. Mount the arms to the arm mount. Do this to each of the 4 mounts.
2. Drill 1/16 holes in the arms approximately 12′ 1″ from the center of the boom; drill a 2nd hole at 12′ 3″ in the bottom arm of the driven element. Be sure to drill all holes straight and in a level plane.

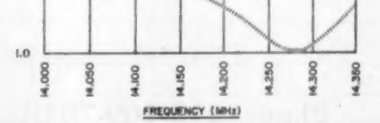


Fig. 3. Standing wave ratio of the four element quad. Although this unit was tuned for minimum SWR in the phone section of the band, even at the low end the SWR barely exceeds 2.5:1.

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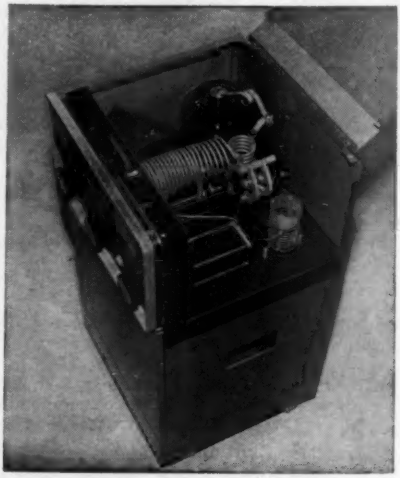

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3. Thread the wire, #14 enameled copper, through each hole, and on the last arm connect the 2 ends together and solder forming a closed loop; do this to each element.
4. Drill a ¼" hole about 1" from each end of the boom.
5. Attach a 10' x 1½" mast at its midpoint to the boom.
6. Drill ¼" hole about 2' down from the top of the mast parallel to the boom.
7. Slide the elements on the boom (a little grease or butter on the boom might help).
8. Attach feedline (52 or 72 ohm coax) to the driven element and run the coax along the quad arm and boom taping it with permanent black tape as you go.
9. Push 5' of the ¼" cable through the holes in the mast and attach the turnbuckles to each end of this wire. Cut the rest of the steel cable evenly and attach the wire to each end of the boom and to the other end of the turnbuckles (Fig. 1). Be sure that the turnbuckles are as wide as they will go before attaching the cable.
10. Raise the antenna to the top of the tower and drop it into place.
11. Tighten rotator bolts.
12. Tighten turnbuckles so that the boom is straight.
13. Run the feedline through the inside of the tower. Drive a 8' ground rod into the ground as near as possible to the base of the tower. Connect the outside braid of the feedline to the ground.

This quad has survived winds of 80 mph on a self-supporting tower 50' above the ground. If additional strength is desired a piece of wood or similar substance can be run through the boom to give additional horizontal support.

The gain of the antenna varies according to what method of measurement is used. Comparing this antenna's gain to what manufacturers claim their antennas get, this antenna exhibits a gain of about 12 dB. This gain was measured by using a S-meter in a communications receiver using a dipole 10 wavelengths away from the antenna.

This is more than enough gain to work most stateside and DX stations using either high or low power.

. . . K0UKN

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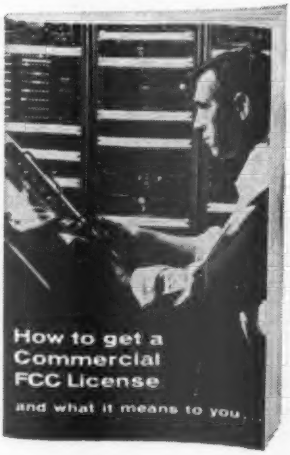
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Tilt that Quad at A Dollar A Foot

When the quad bug hit me three years ago, a basic fact of antenna design came into sharp focus. The delta-quad configuration I planned was comparatively new, and I had no doubt that there would be a long period of pruning and tuning. This called for a simple method of raising and lowering the antenna. Even if my calculations were accurate, I knew the antenna would have to go up and down dozens of times so that it could be adjusted for this particular location in order to correct for the individual conditions such as our unusually poor ground, the proximity of the carport, power lines, etc.

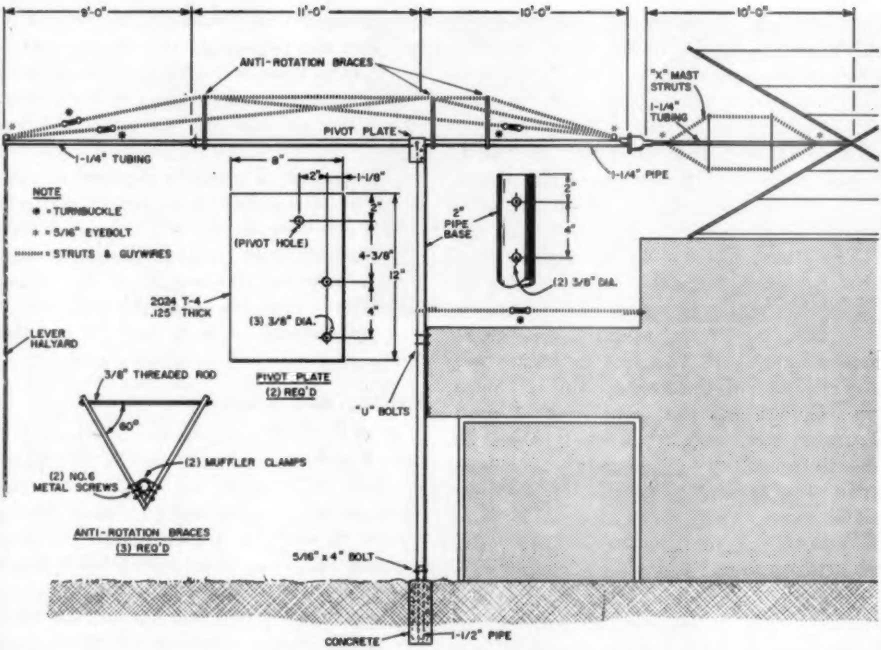
So before the antenna itself was touched, I concentrated on a "tower"—a somewhat generous term—that would permit quick, easy adjustment. Consideration was given to several of the sturdier crank-ups, tilt-overs. Had I been able to afford one of the more de-luxe commercial models, particularly those with power driven winches, there would have been no problem except that of adjusting, cutting, trying and re-adjusting at the 20′ level. The cost of this equipment, however, went far beyond my classification or hobby expense, so I gave the question considerable thought and came up with the gadgetry shown in **Fig. 1.** It is ultra-simple, delightfully inexpensive, and completely effective for lightweight antennas.

Basically, the tower consists of two parts: a solidly set fulcrum at a reasonable height, a lightweight lever arm that would be able to take punishment. The whole works had to be high enough to raise the spider of the quad to a 41′ height (half-wave on 20 M. for the bottom part of the quad square); had to be able to live with summer windstorms with gust velocities of at least 65 MPH.; and had to make the raising-lowering procedure a matter of minimum effort and time. I felt that it could be done at a low cost. It can.

There are two basic elements:

The fulcrum

A height of 21′ seemed like a good fulcrum point for two reasons. First, it would allow the antenna to be lowered to the roof of the house at an angle that would allow me to make adjustments easily. Secondly, standard 2″ black or galvanized pipe comes in such lengths, and with somewhat limited tools, I wanted to keep work to a minimum. I was fortunate in being able to buy from a local surplus metals dealer a piece of lightweight black pipe which has the same outside diameter (2.375″), but has a lighter wall (.121″ vs. .154″). It is lighter in weight, easier to handle and drill, and is cheaper in price. To use this pipe as the fulcrum requires the drilling of two parallel ½″ holes at one end, 2″ down from the end and 4″ apart. (See Fig. 2). An anti-rotation bolt is added later. The fulcrum materials include, in addition to the pipe, two pieces of ⅜th inch aluminum, 8″ x 12″ of a hard alloy such as 2024 T4 or harder. They are drilled with holes to match those on the pipe as shown. The additional ⅜″ hole higher and to the left of the mounting holes, is the actual pivot point. Machine bolts, ½″ x 4″, hard-drawn and with lock washers are used to secure the two plates to the pipe. Mounting to the side of the house or carport is a matter of material available, personal choice, etc. A simple method is shown in **Fig. 1.** A 4′ length of 1½″ pipe was set in a chunk of concrete roughly 1′ x 3′ x 3′ deep, with about a foot of the short pipe above ground, slightly offset from the facia boards of the carport. The base fulcrum is erected in as vertical position as possible by slipping the lower end over the stub in the concrete and tying the upper portion to the house facia in the most convenient and sturdy manner. Drill a 5/16″ hole through both pieces of pipe and use a 5/16″ x 4″ hard-draw machine bolt to keep the 2″ pipe from trying to rotate. Here I used two "U" bolts securely anchored


9'-0"
11'-0"
10'-0"
10'-0"
ANTI-ROTATION BRACES
"X" MAST STRUTS
1-1/4" TUBING
PIVOT PLATE
1-1/4" TUBING
1-1/4" PIPE
8"
2"
1-1/8"
NOTE
● = TURNBUCKLE
+ = 5/16" EYEBOLT
= STRUTS & GUYWIRES
(PIVOT HOLE)
4-3/8"
12"
2" PIPE BASE
2"
4"
(2) 3/8" DIA.
2024 T-4 .125" THICK
(3) 3/8" DIA.
4"
LEVER HALYARD
3/8" THREADED ROD
PIVOT PLATE (2) REQ'D
"U" BOLTS
60°
(2) MUFFLER CLAMPS
(2) NO.6 METAL SCREWS
ANTI-ROTATION BRACES (3) REQ'D
5/16" x 4" BOLT
CONCRETE
1-1/2" PIPE

to the facia, plus a guy wire tightened with a turnbuckle to another facia board. For the base section, that's it!

The lever

The basic component of the lever is a 21′ length of 1¼" black pipe with a ⅜" hole drilled at a point 11′ from one end for the pivot bolt. At right angles to this hole, two 5⁄16" holes are drilled, one 1" from the end of the 11′ side, the second 7" from the 10′ side. These are for the eye bolt used for the bracing cables, and the bolt used to attach the extension arm.

The last major piece of material is a 21′ length of steel tubing with an OD of 1¼". I buy these in Phoenix from wire fence contractors for about $3.25 per length. This tubing is amazingly resilient, and has been used for dozens of tough antenna chores. Cut off ten feet of this length, and set it aside for the top section of the whole works. The lower section is drilled at one end with a 5⁄16th" hole to match the anchor bolt, and with another 5⁄16th" hole about a foot from the end to match the hole in the 1¼" pipe so that the pipe and tubing can be bolted into one unit.

Examination of the sketch of the lever will show that there is a heavy strain on it when it approaches the horizontal position. A pair of braces attached to the arm itself transfers this load to a 3⁄16th" bracing cable. I use two pieces of scrap aluminum channel, about ½" x ½" x 2′6" at each of the two brace points, secured to the pipe by "U" bolts. Really throw your weight into getting

Material List	**Approx. Cost**
1 length 2" pipe, black or galvanized 21′ Fulcrum Base	$11.00
1 length 1¼" pipe, black or galvanized 21′ Lever arm	6.75
1 length 1¼" steel tubing 21′ Lever extension and top mast	3.00
2 pcs. aluminum plate, 8" x 12" x .125" 2024 T-4 or similar pivot plates	3.00
1 pc. 1½" galvanized pipe, 4′ long	1.25
2 pcs. aluminum channel, 3′ long, ½ x ½ x .125 or similar for lever arm strut braces	1.80
4 pcs. aluminum channel, as above 4′ long for cross-bracing top mast—if top mast cross-bracing is used	4.80
25′ ⅛" flexible cable for lever strut, 15′ additional if second facia tie is used	.75
Cable clamps, "U" bolts, eyes as needed for your own variations, plus turnbuckles	5.00
60′ ¼" nylon cord if top mast cross bracing is used	1.80
20′ ¼" nylon cord, or equiv., for lever halyard	.60
	$39.75

The above materials can be purchased at better than these prices in Phoenix from concerns dealing in surplus metals. And even at these prices, with a generous $5.00 for miscellaneous small parts, you are over 40′ at less than a dollar a foot . . . What is more important, you can really tune that antenna.

these on tight. A turnbuckle on the cable makes sure the arm is in proper tension, and basically, we have the lever. With your rotor mounted at this point, you are now slightly more than 31′ above the ground.

Up to 41 Feet. Remember that 10′ length of 1¼" tubing? For a light UHF beam, we've got it made. For a heavier antenna like the DeltaQuad used here, however, the weight (about 25 lbs.) plus the greater wind resistance made me spend a little more time and effort on that top 10′ . . . I cross-braced twice along the length, using the same aluminum channel with two feet extending out on each side of the crosses formed. Since these were inside the quad itself, I used ¼" nylon cord instead of steel cable. Its "stretch-shrink" cycle has had no apparent effect. The antenna bolts to the top of this braced mast. Center of the spider, 41 feet! The usual egg insulator-broken guy wires are attached to the AR-22 rotator here.

The only other item consists of a 20′ length of cord, strong wire or cable which is connected to the bottom of the lever arm. When the antenna is lowered, this halyard hangs down to the ground and is pulled until you can grasp the bottom of the lever itself.

Assembly

Erect the fulcrum post as shown making sure that it is vertical. Raise the lever arm, complete except for antenna, to the roof. It may take a little help to thread the lever arm into the pivot slot, but I do the job myself with an inexpensive block-and-tackle on the top of a very makeshift gin-pole. It takes a ladder to get to the pivot point, and without the gin-pole, getting the ⅜" x 4" pivot bolt can be something of a chore, but with a little push-pull help from a man on the roof, the job can be accomplished in a few minutes. You should be sure as you do this that the halyard at the bottom end of the lever is loose and falling to the ground. Attach your preliminary guys to the rotator, attach the antenna and its coax, and you are set.

The amount of pressure required to raise the antenna depends on its weight and how closely you have stayed with these materials. For this installation, a 23 lb. bucket of sand exactly balances the weight of the whole upper lever complex: next chance I get to pick up a chunk of lead, etc., I'll cut that down.

Raising and lowering

At this QTH, the antenna is attached to the carport on the west side of the house. To lower it, I rotate the quad to the east or to the west, depending on which element I want to work on. I then detach the rotor guy on the west side, release the simple lock that holds the lever to the fulcrum arm and raise the lever so that the antenna starts down. The lever is slowly raised, finally goes to the point that the lever cord is used for the final distance as the antenna comes down to the roof. Outside of antenna rotation, total elapsed time, 10 seconds. After completing the adjustment, the lever cord is pulled and the process reversed. Maybe 15 seconds. Energy expenditure,—little.

On the basis of material costs in Phoenix, we are talking about a total figure for the entire gadget, less guys of about $40.00. The "Tower" has been up for over two years in various sizes and variations. It has taken a lot of punishment from the wind. And most important, it has enabled me to have the antenna easily available for every possible change with the greatest of ease. I think it is a first class investment.

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The second statement is usually not so easily proven. If you have ever struggled up a tower with a twenty-meter beam on your shoulder, or almost slipped a disc when your cubical quad got caught in the stay wires at the thirty-foot level, then I am sure that you agree. There is one way out here, and that is to erect the antenna in two parts, the driven elements and boom in one part, and the reflector assembly comprising the rest.

Fig. 1 shows the boom and driven element section before erection. Ready-made quad parts are not easily available in this country, so we had to start from scratch. We made the boom from 2"OD galvanized water pipe. A ⅛" mild steel plate 6" square is welded to each end of this pipe. One plate has four ¼" holes drilled as shown in the photo, the other end plate has four radial supports welded in place at an angle of approximately 20 degrees to the plate. The third plate has four ¼" holes drilled in exactly the same positions as in the first

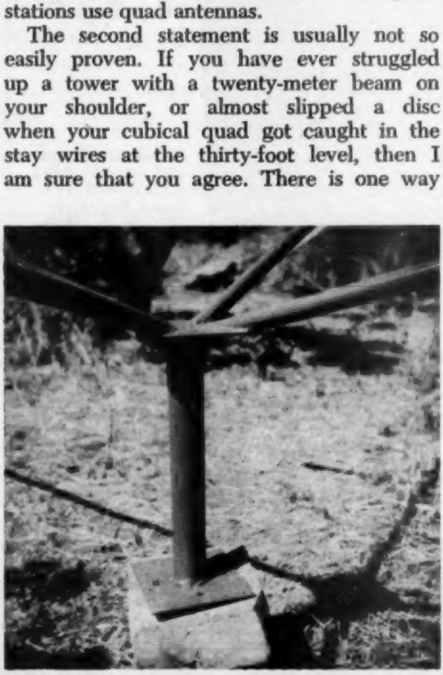

Fig. 1. Boom and driven element section before erection.

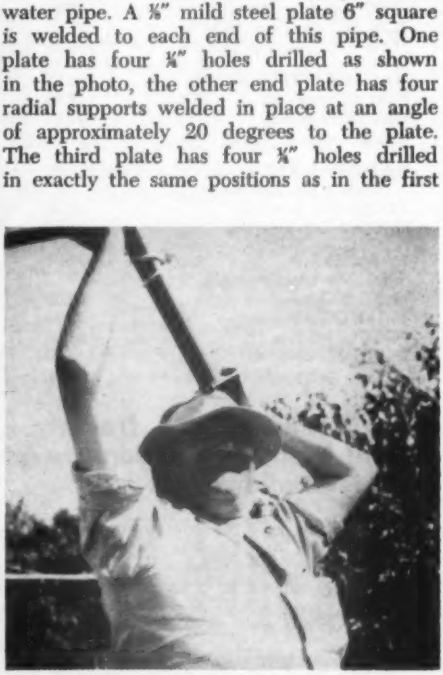

Fig. 2. VK5DS holding the driven element section of the quad.

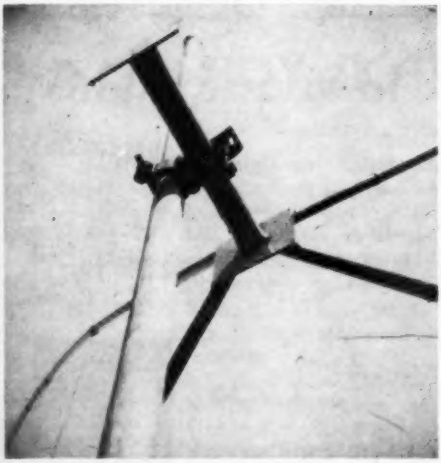

Fig. 3. The boom is attached to the mast with a builder's scaffold clip.

plate as well as the other four radial supports, which are welded, also at 20 degrees.

These eight radial supports are made from galvanized 1" OD steel tubing, each being two feet long. The radials themselves can be made of anything. We used Australian oak, (a long-grained timber), and finished them with marine paint. Fiberglas fishing rods would be better, if available. Whatever material is chosen, the radials need to be about 13' long.

Element lengths can be found in Bill Orr's *Quad Antenna Book,* and it is strongly suggested that the wires be laid out on the ground and individual lengths marked off so that they remain symmetrical when wound onto the radials.

Erection, as mentioned earlier, is very simple. It is quite easy to handle the individual parts of the antenna, as VK5DS demonstrates with the driven elements in the accompanying photograph. (*Fig.* 2)

The tower at VK5VB is a 60' Homelite; we climbed to the top and hauled the driven elements up on the end of a piece of rope, which was tied around the boom. The boom was attached to the rotator (2"OD pipe), with a builder's scaffold clip (*Fig.* 3). We have found these fittings a most convenient way out of the problem of fastening which everyone seems to have with antennas which are too heavy to use TV fastenings.

The other elements are then hauled up the tower and fastened to the boom-plate with four ¼" bolts. (*Fig.* 4)

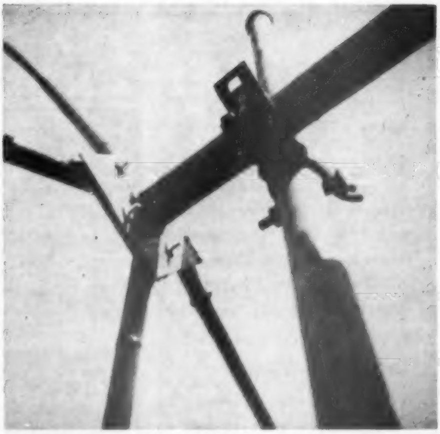

Fig. 4. The other elements of the quad are raised with a rope and fastened to the steel plate on the opposite end of the boom from the driven elements.

If a crank-up tower is used it becomes that much simpler to mount the thing. You can then climb up a stepladder with the antenna sections one at a time and it becomes a one man operation.

We drive each section of the antenna separately with 72 ohm coax and the radiation resistance is correct on all bands up to 50 MHz. This of course is largely because the correct ratio of reflector/driven element spacing has been maintained on all bands.

The finished job, whilst not aesthetically appealing to my wife, I think looks pretty good (*Fig.* 5).

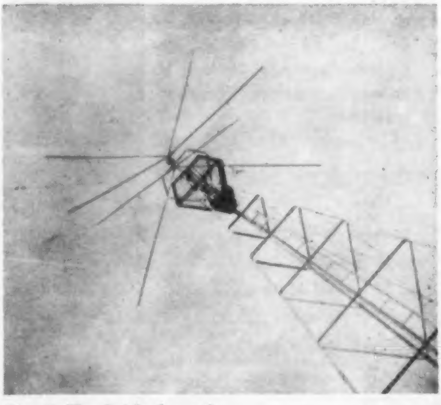

Fig. 5. The finished quad.

. . . VK5BI, VK5VB

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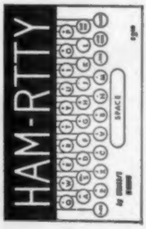
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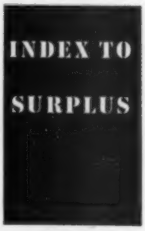
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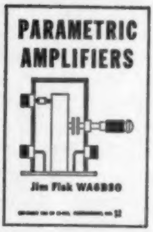
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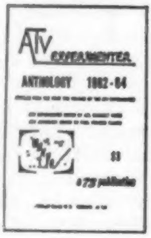
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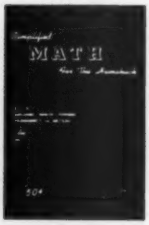
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Bibliography of the Cubical Quad

Since the first published description of the cubical quad by W1DF in QST for November 1948, there has been a veritable flood of quad articles published in the amateur magazines. W1DF noted in his article that the quad *apparently* originated at HCJB in Ecuador; from this rather obscure beginning the quad has grown into one of the most popular amateur antennas. There are two element quads, three element quads, four element quads, quad kits and quad packages—with sizes and prices to fit nearly anyone's space and pocket book. The following is a comprehensive list of cubical quad articles that have appeared in the ham magazines since W1DF's original description back in 1948.

"$6 Quad for Six," W3TBF, 73, November 1961, page 48.

"Three and Four Element Quads," W4AZK, 73, May 1963, page 42.

"The Cubical Quad," W4YM, 73, July 1963, page 48.

"Two Band VHF Quad," W6SFM, 73, July 1963, page 50.

"Putting a Quad Up," K2AAC, 73, July 1963, page 58.

"Three Band three Element Quad," W9AIW, 73, July 1963, page 62.

"Quad-Quad Array for Two," W1CER, 73, May 1964, page 20.

"Poorboy Mark II Quad," K4USK, 73, September 1966, page 14.

"The 'Quad' Antenna," W1DF, QST, November 1948, page 40.

"A Cubical Quad for 20 Meters," W5DQV, QST, January 1955, page 21.

"A Dual Quad for 15 and 10," W8RWW, QST, May 1956, page 26.

"A Tri-Band Quad," W8TUO, QST, September 1956, page 32.

"A Three-Band Quad Antenna System," W4NNQ, QST, April 1957, page 16.

"A Simple Support for Quad Antennas," W3PRU, July 1957, page 26.

"Remote Tuning of the Cubical Quad," K4JMA, QST, February 1958, page 69.

"Quad Antenna Dimensions," W5GGV, QST, April 1958, page 47.

"A Weather Resistant Quad," Weinstock, June 1958, page 42.

"Inexpensive and Rugged Mechanical Construction for Cubical "Quad Antennas," VE3VU, QST, August 1958, page 62.

"More on Quad Dimensions," W1WTF, QST, September 1958, page 24.

"Single-Line Feed for Tri-Band Quads," W3QEF, QST, August 1959, page 20.

"Quad Antenna," K6VIZ, QST, September 1959, page 51.

"The Quadruple Quad," K4LWI, QST, October 1959, page 72.

"Treating Bamboo Quad Elements," W2DY, QST April 1960, page 29.

"All-Metal Quad for 15 Meters," KZ5EG, QST, March 1961, page 36.

"Three-Band Quad for Field Day," K1DRX, QST, April 1961, page 30.

"10 Meters with the All-Metal Quad," KZ5EG, QST, May 1961, page 15.

"Close Spacing the W3QEF Quad," W7BTB, QST, January 1962, page 35.

"Shortening Quad Elements," W7BTB, QST, March 1962, page 58.

"Treating Bamboo Quad Arms," W6PPO, QST, March 1962, page 59.

"Interlaced Quad Array for 50 and 144 Mc," K8WYU, QST, February 1963, page 11.

"The Multielement Quad," W0AIW, QST, May 1963, page 11.

"The Short Quad," WA8BHK, QST, February 1964, page 46.

"Strong, Lightweight Construction for the Three-Band Quad," WA4FRY and K4AVU QST, June 1964, page 36.

"Strengthening the 'Lightweight' Quad," WA4FRY and K4AVU, QST, December 1964, page 71.

"Store-Bought Hardware for the Cubical Quad," W0MHV, QST, July 1965, page 20.

"Quadrangle," K0JTP, QST, September 1965, page 20.

"Yagi vs. Quad," W4RBZ, QST, October 1966, page 20.

"Practical Consideration and Application in a Multielement Quad," W5HHV, QST, February 1967, page 27.

"Cubical Quad, Topic Number One," Staff, CQ, December 1948, page 37.

"Constructing the Cubical Quad," Hoffman, CQ, June 1949, page 11.

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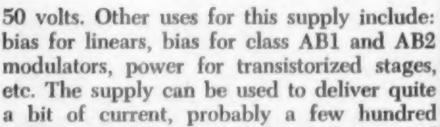
"A Three-band Quad," W0WEP, CQ, July 1957, page 32.
"Tunable Quad," KZ5UJ, CQ, July 1958, page 50.
"A Broadband Cubical Quad Antenna," K2ODT, CQ, July 1959, page 44.
"The Quad Devilcatcher," W0AIN, CQ, February 1960, page 58.
"The Delta Quad," W6SFM, CQ, September 1961, page 46.
"Multiband Quads," G6XN, CQ, November 1962, page 53.

. . . Jim Fisk, W1DTY

Simple Bias Supply

Possibly the reason that many amateurs do not use protective bias in their transmitters is that bias supplies are usually expensive and hard to locate. There are very few transformers that are suitable for bias supply use on the surplus market and new ones are costly. A very simple supply can be made from the heater supply of the transmitter. The circuit shown is a half-wave tripler operating from the 6.3 volt heater line. SR1, SR2, and SR3 are low voltage silicon rectifiers. Usually the filtering is adequate at point X. If more filtering is desired, R2 and C4 can be added. The output should be between 20 and 30 volts. If a higher voltage is desired, taking the ac off a 10 or 12 volt winding, if one is available, will raise the voltage to approximately 50 volts. Other uses for this supply include: bias for linears, bias for class AB1 and AB2 modulators, power for transistorized stages, etc. The supply can be used to deliver quite a bit of current, probably a few hundred milliamperes. It has good regulation and can be used for bias in stages where grid current is drawn, such as class B modulators, etc. The total cost for the supply should not exceed $3 or $4, and can be built for considerably less if some of the parts are in the junkbox.



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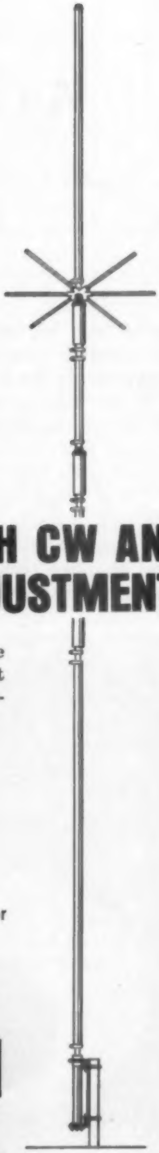

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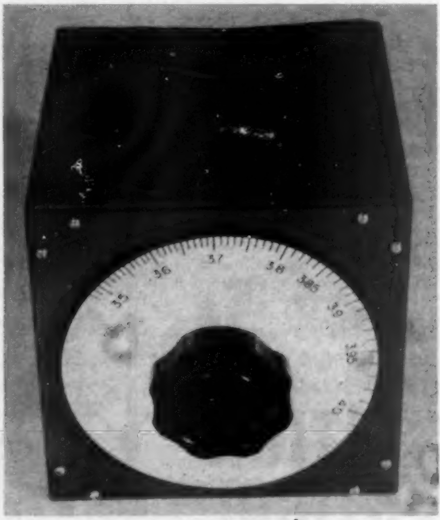
An FET VFO for 80 Meters

One of the big advantages of the field effect transistor oscillator is that it does not appreciably load down the tuned circuit. If you take a very close look at the circuit Q versus frequency stability curve you'll find that highly stable oscillators are coincident with high Q tanks. With the relatively low impedances encountered with the bipolar transistor[1], circuit loading is a severe problem which seriously affects frequency stability. In addition, the element capacitance of the bipolar device is very complex, varying with voltage, temperature *and* current. It is difficult to predict exactly what a given device will do because the rate of change of capacitance is a function of the bias level, and varies from device to device. On the other hand, the capacitance of the FET is almost completely unaffected by the source current, and the factors that influence FET capacitances always increase with temperature. Since the properly designed FET oscillator always has a positive temperature coefficient it is relatively easy to compensate.



The 80 meter FET VFO. The dial is made from a National AVD-250 planetary drive; the scale is printed on a paper disc which is glued to a 4 inch aluminum disc. The drive mechanism is on the rear of the panel; the aluminum disc is attached by means of screws and ¼ inch spacers.

The complex capacitance of the bipolar device has *both* negative and positive temperature coefficients, and for wide excursions in temperature, bipolar transistor oscillators are very difficult to compensate. Never the less, transistors inherently generate very little heat, and in amateur applications this difficulty is often not apparent. I can remember spending three weeks of continuous labor trying to compensate a 3 MHz oscillator that was to be used on one of our space vehicles; the transistors finally had to be changed before a stable unit was obtained.

An example of the frequency variance with temperature of two oscillators, one with an FET and one with a 2N918 bipolar transistor is shown in Fig. 1. Note that whereas the frequency of the FET circuit decreases in a somewhat linear manner, the frequency of the bipolar oscillator first increases and then decreases. The negative temperature coefficient of capacitance dominates when the frequency increases and the positive coefficient as the frequency decreases. This type of curve obviously *can not* be compensated with a temperature sensitive capacitor in the tank circuit. It is also apparent from this graph that the bipolar circuit has a larger drift in frequency for a given change in temperature over most of the range. In many cases the ham oscillator is operated within the temperature range at the crest of the frequency curve where these undesired effects go unnoticed.

---

[1] The bipolar transistor refers to conventional junction transistors made up of P-N junctions at the emitter, base and collector. In these transistors the current through the junction consists of **both** electrons and holes (absence of electrons). Because there are two types of current carriers (electrons and holes), these devices are referred to as "bipolar". On the other hand, the field effect transistor is a "unipolar" device because the current carriers are **either** electrons or holes, depending on whether it is an N- or P-channel device.

In the VFO described in this article, FET's are used in the oscillator and buffer stages and a bipolar transistor is used in the power output stage. The oscillator itself is a conventional series-tuned Colpitts or Clapp circuit with large silver mica capacitors providing the necessary feedback. The large value of these capacitors tends to swamp out any changes of capacitance within the device itself. The frequency drift of this unit was so small (probably because it was operated at room temperature near no vacuum tube heat generators) that no temperature compensation was required. In most cases no compensation should be necessary, but if thermal drift is a problem, a negative temperature coefficient capacitor may be added in parallel with the 50 pF tuning capacitor as shown by the dotted lines in **Fig. 2.** In the event this compensating capacitor is required, the 75 pF capacitor should be reduced by a like amount.

Since a compact unit was desired, toroidal coils were used to maintain high Q without massive air wound inductors. Since there is virtually no field around a toroidal inductor, they may be placed near other objects in the circuit without affecting their Q. Sometimes this low amount of external field can be a problem because it's difficult to couple a grid dipper to the circuit to find out its resonant frequency. In addition, toroids are quite susceptible to 60 hertz ham pickup, and this is accentuated by the high impedance FET, so care must be taken to shield the circuit properly. In the author's case the hum was completely eliminated when the circuitry was mounted in a metal box.

To reduce loading on the oscillator stage, an FET source follower is used as an untuned buffer stage. The low value of coupling capacitance, 5.6 pF, serves to further reduce the loading on the oscillator. To eliminate any possiblie pulling or resonance effects, no tuned circuit is used in the buffer stage. The stage shown in the schematic exhibits extremely high input impedance and is a very effective isolator; when the output stage is keyed, there is no perceptible change in the rf voltage across the oscillator tank and the frequency remains rock stable.

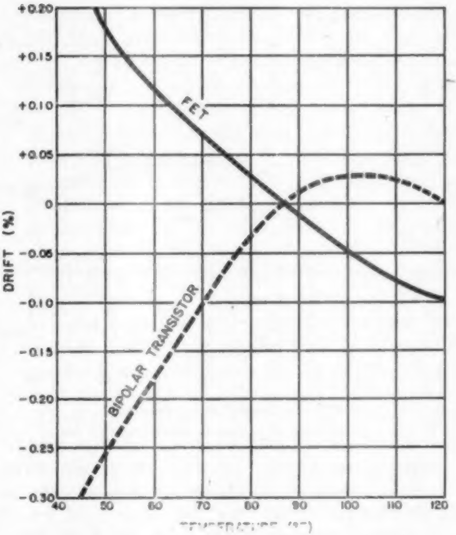
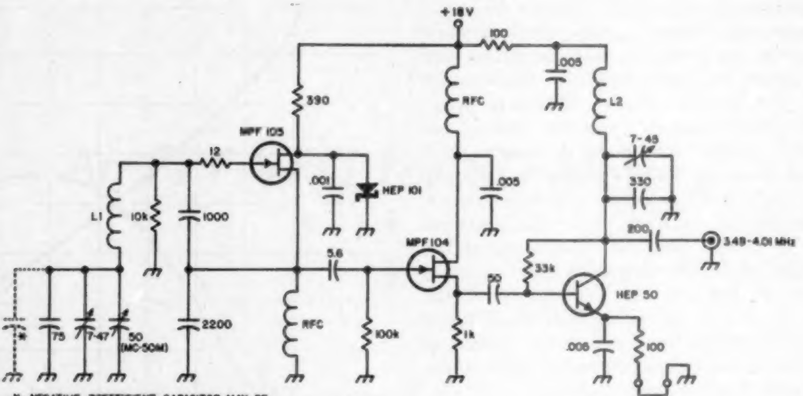


Fig. 1. Typical drift characteristics of FET and bipolar oscillators. This graph is based on a starting point of 30° C (86° F) and shows that the bipolar transistor has both negative and positive temperature characteristics while the FET capacitance has a positive temperature coefficient (causing the frequency to go down).

The stability of the supply voltage to the osicllator is maintained by the 400 milliwatt, 9 volt zener diode (HEP 101) across the drain to ground. With the circuit constants shown, the voltage on the drain of the MPF 105 field effect transistor remains within 1% of the Zener voltage as the supply voltage varies from 13 to 25 volts.

The output stage uses a low cost silicon transistor in a conventional class C rf power amplifier circuit. At 4 MHz this stage has about 25 dB gain and provides 2.0 volts RMS output; this is more than sufficient to drive most transmitters. If the second harmonic at 7 MHz is desired, it is recommended that another HEP 50 stage be added

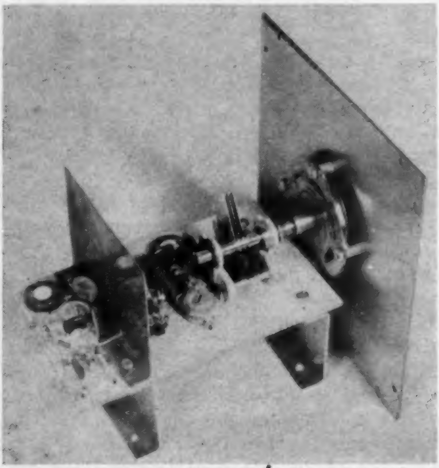


* NEGATIVE COEFFICIENT CAPACITOR MAY BE
REQUIRED FOR TEMPERATURE COMPENSATION.

L1 53 TURNS NO. 26 ON 0.68" TOROID (AMI-TRON T-68-2)
L2 27 TURNS NO. 26 ON 0.68" TOROID (AMI-TRON T-68-2)

Fig. 2. The RFC's used in the FET 80 meter VFO are miniature 1 mH units available from J. W. Miller. The oscillator and output stage as shown here will run continuously. To key the output, remove the jumper marked "key" and connect the two terminals to your key. The two toroids are available postpaid anywhere in the U.S.A. for $1.00 from Ami-Tron Associates, 12033 Otsego Street, North Hollywood, California 91607.

as a doubler. In the original model of this VFO the final stage was operated straight through on 80 meters and as a doubler for the higher bands. Although there was sufficient drive on 40 meters, there was not enough output on 20, 15 and 10. In fact, at the higher frequencies, the transmitter operated at the resonant frequency of the doubler tank (or its harmonic) and refused to be varied by the FET oscillator!



Interior of the 80 meter VFO. The FET oscillator and buffer are in front of the shield, the HEP 50 output stage to the rear. The planetary drive is attached to the front panel with spacers. The screws and spacers which hold the dial pass through a 1¼ inch hole in the panel.

In this VFO all the components were mounted on a ⅛ inch sheet of micarta 3½ inches wide and 5½ inches long. Soldering terminals were provided by drilling holes in the micarta with a number 42 drill and installing Vector pins (Vector T9.4). This method is very rigid mechanically and is easy to duplicate. A narrow strip of thin copper was mounted in the center of the micarta terminal board to provide a common ground for the circuitry. At the front of the board a Hammarlund MC-50M variable capacitor was mounted with the copper strip between it and the board. Except for the toroids, all the components were mounted by simply soldering them to the Vector terminals. By placing the body of the component next to the board and by using short leads, almost all vibration and its effects were eliminated. In fact, the completed unit can be slammed down on the bench with no perceptible change in frequency.

When winding the toroids, the turns should be spaced to completely fill up the circumference of the core. In this way maximum Q is obtained. After the toroids are wound, a little polystyrene Q-dope will hold the turns in place. The completed toroids are mounted to the board with 3⁄16 inch flat head nylon screws that came in a nylon screw assortment from the local hardware emporium. If you can't find any nylon screws, brass screws and fiber washers will work as well.

The frequency of the oscillator is set to the proper range with the 47 pF trimmer capacitor. With the variable capacitor plates fully meshed, set the oscillator frequency to about 3480 kHz with the trimmer; when the variable is fully open, the output frequency should be approximately 4020 kHz. If a full 500 kHz range cannot be obtained, decrease the value of the 75 pF shunting capacitor to the next lowest value (68 pF) and try it again. If you want to reduce the frequency coverage, increase the value of the 75 pF capacitor. The power output stage is adjusted for maximum output at 3750 kHz.

Although this unit was designed specifically for 80 meters, it may be used on other frequency ranges by simply changing the number of turns on the toroid coils. Remember that the center frequency of the desired range is set with the inductance; the frequency spread is controlled by the size of the 75 pF shunting capacitor. In some cases a little juggling back and forth between the capacitor and inductor may be required to get the desired results, but it is not difficult nor time consuming.

Conventional bipolar transistors have eliminated many of the problems in stable VFO design, but they still have several minor disadvantages. The field effect transistor virtually eliminates these dsiadvantages and combines the low power and low heat of the bipolar device with the high impedance and predictable element capacitance characteristics of the vacuum tube. This VFO has provided such extremely stable results on 80 meters that an 8 MHz unit is under construction for use on six and two.

. . . W1DTY

Thermistors

We normally think of the lowly resistor as just that and only a load for a tube or transistor, a voltage dividing device, or a voltage dropping device. Modern science has provided to us with several exotic gadgets in the form of resistors with very special characteristics.

The most common of these is the temperature dependent resistor, better known as the thermistor. One of the most prevalent uses for the thermistor is in the audio circuits of the transistor radio where it limits the current as the temperature rises and thus prevents thermal run away. Many of them are used in ultra sensitive thermometers operating over a very narrow range. They can be made so small that in laboratories they are imbedded under the skin of animals to keep a constant check on body temperature. Others have been used to check wind velocity. Here two are used. A small voltage is applied to both so that they heat up. One is placed in the wind stream and the other is protected from the wind. Of course the one in the wind will cool down just as you cool your coffee by blowing on it. Measuring the current difference from one to the other will tell how hard the wind blows.

Another type, not as well known, is voltage dependent resistor or varistor. These also come in many sizes and shapes. The TV repair boys have run into these where they are used for stabilizing the line deflection against voltage fluctuations, tube ageing, etc. They are also necessary in automatic synchronization circuits.

Varistors are used in great quantities for spark suppression and contact protection where the resistor acts to reduce voltage build-up and subsequent sparking across relay contacts.

Another use of varistors is voltage control. They cannot do the job of the fancy tube type or zener diodes but for the size and price they do give a high degree of stabilization.

Still another special resistor is the light dependent resistor. Actually this is a type of photo cell, one that does not generate electricity when exposed to light but only changes its resistance. These cells are usually made with a layer of compressed and sintered cadmium sulfide. Their resistance will range from 100 ohms in strong light to 100,000,000 in total darkness. The spectral sensitivity is fantastic, ranging from visable light to a good way into the infrared range. The peak sensitivity is at 6800 angstrom which is the center of the visable red.

. . . Ralph Hanna W8QUR

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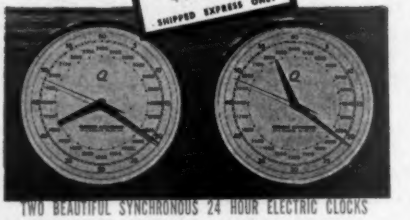

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Tube Symptom Troubleshooting

Here are some useful hints to help you fix your inoperative gear.

Troubleshooting procedures involving tubes naturally cover equipment involved in any ham interest, including ATV. This article contains a general accumulation of suggestions based on experience I have had in repairing electronic equipment under pressure which invariably leads to work routines that cut away as much lost motion as possible. Whether you are in a hurry to repair something or not, however, any clues furnished by faulty equipment which you correctly interpret and therefore avoid following false leads makes you a better troubleshooter. I know you probably check tubes early in the routine but how do you check them? Are you getting the most out of each observation, each test, each substitution? Any check you make 'just to see what happens' is aimless and although it will probably get the equipment fixed it isn't likely to contribute new information to make it easier the next time. Here are some clew furnished by tubes you may not be aware of:

1. Gassy Tube: The blue glow is not necessarily bad. If it wanders around aimlessly in the envelope like in a smoke-filled room, that's bad. Small, bright patches of blue are normal. They are also useful troubleshooting guides since they indicate a functioning tube that is being driven. For example, observe the action of an audio power output tube or a horizontal sweep output tube with an without drive. Watch these blue patches ignite with the tube operating and go out when the tube is disabled or drive removed.

2. Nosiy tube. You tap or rock the tube and the speaker emits noise. So you pull the tube, put in a new one, and the noise stops so the old tube was no good. Not necessarily. Pulling out the old and pushing in the new probably cleaned the dirty socket contacts. Put the old one back in just for the heck of it—you probably don't really need the new one and you have saved face and money.

3. Microphonic tube. Two causes for this but one is an unnatural cause; rapping on the tube envelop to "check" it. Quit doing that. My experience includes a stereo system that was checked for every conceivable thing because of low frequency distortion and it was only a howling 12AX7. Moral here is, automatically blame tubes for everything because they are often to blame and the're easier to get to. I think it possible for new tubes and very old ones to be equally suspect. Manufacturers believe that a tube that survives the 90 day warranty will have a long life. Tension of grid wires causes the frame-grid tube to be prime microphonic candidate.

4. Red plates do not necessarily mean the tube is ruined or at fault. You are familiar with the usual maladjustments that cause excess plate dissipation in a transmitter. Are you familiar with the series B+ circuit? If an overload occurs in the low B+, the audio output tube is overworked and turns red: but the fault is not in the tube and seldom damages it. A tv horizontal output tube turns red if drive is lost so check the horizontal oscillator. In a color set, the high-voltage rectifier may go red if the high-voltage regulator tube fails. These are all examples of a fault indicated by one tube but caused by another tube or component.

5. Tube shields. You do replace all tube shields don't you? Are you sure that they are well seated and grounded. A good way to inject a signal into a tube is to connect the signal to the tube shield and then pull the shield up so that it doesn't touch ground. Using the same reasoning, an ungrounded shield can cause more grief than a missing shield. Manufacturer's got so tired of missing shields that they developed one that won't come off. The top portion is turned counterclockwise and pushed down. Hopefully, the top portion is pulled up and locked in place after service is rendered. If adding a shield cures a problem, be suspicious. Here is an example: By adding a shield in a ratio detector circuit, sound dis-

tortion was eliminated. However, the shield really added a reactance that should have been added by adjusting the sound transformer. Of course, we are speaking of manufactured and proven equipment in this instance—not experimental work.

6. Filament dead so tube is dead because putting in a new tube cured it. Also, maybe not so. If the tube has a base, crimp the filament pins with a sidecutter. Hardworking tubes like the 5U4 get pretty hot and the solder can granulate. Then again, it may not have been soldered well in manufacture and electrolysis has finally insulated the connection. Try it—what have you got to lose? By the wey, if the tube socket pins get that hot, better resolder them, too.

7. Clever trick. Look into glass envelopes now and then and try to interpret abnormal indications. Suppose a technician sees the 6V6 screen glowing and correctly surmises that the audio output transformer is open, causing the screen to dissipate far above normal. Didn't need a meter, a speaker, bench work, substitute tubes, etc., to solve that one.

8. Cracked envelope. You should always perform a visual inspection of tubes before pulling them lest you cut yourself on cracked glass. A cracked envelope will often show a white flare somewhere on the glass. Even if you don't cut yourself, it's a nusiance to pick bits of glass out of the socket well. Might be a good idea to buy one of the inexpensive tube pullers and save your fingers.

9. Heater cathode leakage. A television provides more clues than a radio. It causes 60-hertz hum or one black bar or the pix tube. The filter problem (120-hertz hum) causes two black bars. If the hum gets into the sweep circuits instead of the video, check for leakage in deflection tubes and the pix tube will provide evidence in the form of picture bending or poor color convergence. (This stuff goes on. We've got to try and make this brief but a book could be written on the things a tube will tell you). The intensitity of the hum in the audio channel provides a clue because the closer the defective tube is to the antenna the more amplification the hum receives. When you build equipment, take the precautions given you by the tube manufacturer concerning tube orientation since this often relates to the plane of the filament.

10. Mystery tubes. If you can't read the tube type on the glass envelope, breathe on it as you would when cleaning your spectacles. If this doesn't work, put the tube in the refrigerator ice compartment. Often, frost will form in a manner that will outline the disappearing legend. The interior of the tube is frequently distinctive enough to determine the type. The 6AV6 and 6AL5 are easy ones.

11. Suffix letter A. The letter "A" following tube type often means the manufacturer has improved a tube; sometimes because the original was a stinker. Sometimes because of a specific change such as delayed warm-up characteristics. Two examples are: the 6U8 and 6U8A and the 6AQ5 and 6AQ5A.

12. Tubes are not spark plugs. Don't put in a round of new ones at regular intervals to give the set that "old zing". Too many circuits still detune and must be adjusted after tube replacement in wholesale lots. Anyway, that's guess work.

13. The best tube tester is a new tube. If you want to see filaments go and microphonics develop, take out all the tubes and brown-bag'em to the tube tester and back again. Dynamic testing of a tube is worthwhile. The short test is a ghastly thing. Some people hammer the daylights out of the poor tube and I don't know if they are vehemently trying to prove or disprove that a short circuit exists. A good gadget is a soft rubber ball mounted on a dowel rod. Tap the tube gently with it or tap the chassis near the tube (a little harder) with the same tool.

14. Tube substitutes. Let's be suspicious except in emergencies. Unless your vessel is marooned and Captian Video asks you to raise the space rangers, it is better to get the original type but hardly ever necessary to specify the original manufacturer of the equipment. You should use the same type if a tube manufacturer has his name on it to avoid the thing called divided responsibility. For example, a GE serviceman is reluctant to replace an inwarrantly RCA tube without charge and you are not prepared to take warranty tubes to two or more places if they should fail. An example of tubes that are erroneously listed as substitutes are: 6BC8, 6BQ7A, and 6BK7. Get the original type since interchanging these can bring you an alignment job. At the other extreme, I once used a 6K6 to temporarily substitute for a 6X5: had to chop

off unused pins and the control grid performed well as one of the rectifier plates. It was an emergency. A 6AV6 will always substitute for a 6AT6 if you want a little more sound.

15. Tube plate caps. Easy does it! Don't make extra work for yourself. Take the connector off very carefully. It will take you about one hour of cross-eyed work to replace the socket on a picture tube if you pull the plug off too quickly. But you should pull these things off and make sure there is continuity. The hot plate cap of a transmitting tube, highpower PA tube, horizontal deflection tube, etc., often renders the solder joint useless. Sometimes, the connection works but high-voltage causes a constant arc that continues to deteriorate the joint and produces hard-to-trace interfering signals. If the heat has also hardened the lead, perhaps you should replace both the cap and the lead.

16. Tube swapping. Good idea if the tubes are of the same type. A transmitter may have two or three tubes of the same type for low level audio, speech amplifier. vox amplifier, etc. By swapping tubes you can probably trace your problem by generating a new one. There are limits to this and fringe benefits, too. If a tube is marginal and operating in a critical circuit, swap it with a like tube in a circuit which is less critical. Often this will not only disclose the trouble but allow you to use the marginal tube a little longer. Tubes in the microphone amplifier stage may be slightly microphonic or low gain but work well in a higher level stage. When troubleshooting television, swap sweep circuit tubes to track down problems but don't get carried away in rf and video circuits.

17. Filament continuity. The rule of thumb is this: If the tube has seven pins, check between pins 3 and 4. If nine pins, check between 4 and 5 and 9. All do not use pin 9 (such as 6BQ7A) but 4 and 5 are always used. For octal sockets, usually pins 2 and 7. Rectifiers (like 5U4) are pins 2 and 8. If 2 and 7 don't work, check 7 and 8 (like 6SJ7).

18. Tube reinsertion. Before you pull a keyless tube from a socket that is obviously hard to reach or see, remember the trouble you had the last time trying to get it back in. The simple way is to remove the tube without allowing it to rotate in the hand until you get it into the light. Then, remember its orientation with respect to the chassis. Someday, when you have the chassis out, do this: Take a narrow strip of masking tape and stick it to the side of the tube and allow it to extend down and attach to the shield socket and then cut it at the top of the shield socket. Your sense of feel will tell you when the edges of the cut ends are aligned for subsequent replacement. Of course, you can often see the socket shield but not down into the socket: in this case the tape works very well.

Big bonus hint: Once upon a time, the tube manufacturers built a clever tube box for any kind of little tube but they didn't tell anyone how to use it. I suggest a game. Give a boxed tube to a friend and ask him to remove the tube. He will either open one end and pick away at it to get the tube out, or he will open both ends and push the tube out. Either way is illegal. If you'll look in the box, you'll see two cardboard wedges anchored at the box corners. If you invert the box over your hand and push at these corners of the box (using thumb and forefinger, naturally) where the wedges are attached, the wedges will expand and allow the tube to fall into your hand. It's a little thing but it looks so, well–professional–you know what I mean?

The ATV ham shouldn't use the family tv for a monitor. Especially, for video input, it's necessary to add a switch and jack to "jeep" the instrument which will void the warranty. It isn't a question of whether the serviceman likes it or not since you obviously fix your own tv–don't you? I could give you a list of televisions that can't be "jeeped" anyway: especially color sets. The alternative is to get an old dog from the tv shop or garage sale and fix it up; also applying the suggestions on tube troubleshooting I've given you plus these hints particularly applicable to tv.

Don't fuss with tubes and replace the tube rectifier with diodes to get enough width and then discover the yoke isn't pushed all the way forward. Adjust the ion trap (if any) for brightest raster with the brightness control at maximum. Do not use the ion trap to get rid of neck shadows at the expense of brightness. Use the centering adjustments for that. You may be surprised to find B+ in an old set too high instead of too low. This can happen if a number of original tubes are still in use since they have all declined and the total current drain is less than the "no life" value. If you aggrevate this situation by putting in diodes for rectifiers, expect some other breakdowns such as electrolytics. Don't borrow trouble. When you get a used tv, inspect the kinescope faceplate for deep scratches which are a dangerous invitation to implosion. Especially since I'm afraid you're going to let it run in the shack without its cabinet—a bad prac tice. When you get the television running for the first time, the picture may indicate poor emission. It might be caused by a long period of idleness so put on the picture tube brightener and then take it off again after a while—don't use it if you don't have to

More on the tv which has sat idle a long while. The electrolytics can be reformed first and possible failures can be avoided. To do this, apply the line voltage through a Variac for while with the B+ output disconnected from the load and input not too low to endanger the power transformer. This suggestion is for us cheapskates. Others prefer to apply higher than normal voltage and blow what's going to blow—tch! tch! If you need a replacement picture tube, investigate the possibility of a substitute at lower cost. The years following manufacturer of your set finds new types and the cost of types fluctuating up and down according to the number manufactured. The majority of instruments use the "21 inch" tube with the portable sizes following close behind and the sizes above 21 inch being the poorest investment.

Look out for those dangerous metal picture tubes since they bite everywhere. They don't kill you but you break your neck jumping out of the way. If you get corona from these, it will usually be around the bell (forward of the yoke). To cure this, take the picture tube out and wash it thoroughly with soap and water, dry, and apply a good wax all around the bell. When you wash glass envelopes, be careful with the acquadag coating which forms one condenser plate for high voltage.

Lastly, don't improve the tv with changes in tube types for better signal-to-noise and such unless you got a good plan; like the lone ranger. It's usually easier to preamplify outboard and the 432-MHz converter can use the preamplifier as its if amplifier.

You know, I think the most embarassing thing of all is to get deep into chassis troubleshooting and then discover a tube under there—yech!

. . . WA0NEA

Faraday Shields

A simple device that for some reason has fallen into oblivion is the Faraday screen or shield. It is still important enough to the FCC that it is included in the Tech and General class license exam.

All of you, I am sure, know that a Faraday screen looks like a big comb with one common wire with a lot of other wires running out from it and not connected on the other end.

The Faraday shield eliminates capacitive coupling between coils. The desired signal should be inductively coupled because this is tuned to the desired frequency, be it the antenna or another coil. The capacitive coupling does not see anything except a mass of metal and any frequency present can be transferred. This can cause all kinds of stray stuff to show up on the feed lines and especially some of the harmonics and even some of the subharmonics in the case of a transmitter with multiplier stages. All of these things can cause or add to the TVI problem.

The Faraday screen prevents the electric field from one coil reaching the other, but has no effect on the magnetic field. This is because of the open-ended wires. No current can flow in an open wire and current must flow to give effective magnetic shielding with non-magnetic material.

Faraday screens can be made quite easy and if you have harmonic troubles, and don't know what to do next, why don't you try one? The screen should be a bit longer than the coils to be coupled. Wire size? No. 18 is about the largest that should be used. Space the wires about the same as the diameter of the wire. One good way to make one would be to glue a bunch of wires to a thin piece of plastic. This would give excellent support and a couple of brackets would make an easy job of mounting. If you have a printed board making kit, it would be simple to draw a bunch of lines with the etch stop pen, then etch away the copper between the lines.

. . . Ralph Hanna W8QUR

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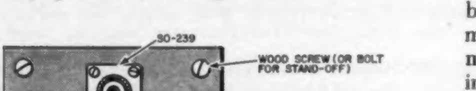
A $2 200-Watt Dummy Load

Stop creating QRM. Test into an inexpensive dummy load.

Everybody tells the radio amateur, "You ought to feed all of your test transmissions into a dummy antenna, and not radiate needless interference." For a starter does he go out and buy a Bird Electronics 1,000 watt rf watt meter, Model 694 for only $365.00? Works very nicely throughout the 2-30 MHz range, according to the spec's. Or maybe the Waters dummy load for $135—a very nice item—wish I had one. Or perhaps the Heathkit Cantenna for only 10 bucks, plus postage and four quarts of oil. All of the above items are certainly reasonably priced, according to one's needs; but what do you say to the ham with 150 or 200 watts input and only a couple of bucks to spare? Cheer up, help is on the way . . .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Details of the Meshna-special dummy load. The resistors are 35¢ apiece. The board is 4 x 10", and preferably fiber glass or bakelite. The resistors are supported by ½" or longer spacers.

"Noninductive, late style 50 ohm, 25 watt resistors, 35c," said the ad. So I bought four of these from Meshna . . . four of these in series-parallel connection should give 50 ohms effective resistance, with 100 watts of heat dissipating ability. Anyone can see from our most elementary drawing that you don't need to be an electronic genius to duplicate this very simple item. The only additional cost was for an Amphenol type SO-239 fitting and the surplus Fiberglass board on which the whole assembly is mounted. If you feel really "sharp" you might choose to run the center conductor in the form of a three-wire bus, or maybe a copper strip. This is supposed to cut down on "stray inductance" and make the dummy load resistance closer to 100% non-reactive. I checked out the final product on a Heathkit DX-100 transmitter and found that the SWR was fairly low on 40 meters, reading 1.05 to 1 on a Knight SWR Meter. This rose to 1.2 to 1 on the 21-MHz band. Maybe the resistors are non-inductive at 2 or 3 MHz, but they seem to become more reactive as the frequency increases. But for two bucks, you can't ask for perfection, can you?

Maybe not, but you can try. I swiped a few feet of the wife's Reynolds-Wrap from the kitchen. I made up some experimental coils from the aluminum strip, approximately 1 inch wide, and shaped the coils to resemble the resistors. With the trusty grid-dip oscillator, they resonated close to 68 MHz when shunted with a presision 100 pF. condenser. The coil was connected directly to the capacitor terminals—this comes too close to channel 4 in our household—so the experiments were not long in progress! The "ball-park" figure of 0.05 μH of inductance for the resistor is reasonably close. The calculated value of L for a typical resistor was 0.03 μH. They are "spiral-cut" and the pitch varies slightly in production. Probably this explains the slight reactive quality of the dummy load resistors.

It might be possible, with a little experimenting and a different physical layout, to come up with a cancellation of most of these effects, and possibly bring the SWR down to 1.1 to 1 throughout the HF amateur bands. We stopped short of this goal, since the load as it presently stands does an excellent job on all the ham bands 80 thru 15 meters. It should be possible to feed more power into the "dummy" if you place it outdoors on a cold winter's night. As it stands, you can feed the rf output from a 250 or 300 watt rig, key-down half the time, without additional cooling.

. . . W2OLU

Tired of Dead Batteries?

Don't get caught with your battery down. Install an extra battery with little trouble.

Shortly after I first started mobile operation I experienced a pitfall that happens sooner or later . . . . . being stranded with a dead battery (and sometimes in awkward locations).

I started to carry an extra battery but it was a nuisance using jumber cables and I was never sure how much charge was left in the extra battery. So I decided to hook it up in parallel with the main car battery.

I read some of the articles in the ham publications and most of them used complicated hookups with lots of relays to install the extra battery. One author even went so far as to use a relay to disconnect the extra battery when starting the car motor. To me this all seemed ridiculous.

Figure one shows the simple hookup I used. All the radio equipment (and some extra lights that I use a lot for camping and extended periods of mobile relay operation at night) are connected to the extra battery side of the relay.

With the relay coil being connected to the ignition switch several bonus features are to be had, namely:

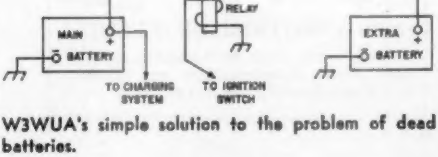
1. Operation with the motor off drains only the extra battery, leaving the mean battery to start the motor.
2. Both batteries supply current to start the motor, a big bonus on those cold winter mornings.[*]
3. Both batteries are charged automatically. No special adjustments to the voltage regulator, etc, are needed.
4. Any thing left turned on overnight will drain only one battery.
5. When a battery "goes west" of old age (which seems to happen anytime or anywhere) the other battery will start the car and get you home.

I find it best to keep the best battery in the front (factory installed position). This system has worked out perfect for me in three cars and I am now installing it in my fourth car.

It is a great comfort to know I won't be stranded during extended mobile especially in Civil Air Patrol operation where it is common to operate continuously in one spot for several days. In this type of operation I operate usually two frequencies at the same time and also monitor other services as the situation might require.

For the price of a battery and a relay (much cheaper then a alternator system and in many ways even better) you can have a lot of freedom from worry about the "power source" in your car.

. . . W3WVA



W3WUA's simple solution to the problem of dead batteries.

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[*] Ignition switches vary . . . use your ingenuity to get the results desired. In the later cars it might be best to connect to the wire going to the spark coil.

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Churchville, Pa. 18966

The Easy Way to Decibels

One of the most often used yet little understood terms in amateur radio is the decibel, commonly known as the dB. Articles and introductions to this not-too-complex topic are generally presented with the formula:

$$dB = 10 \log \frac{V_2}{V_1} \text{ for power and}$$

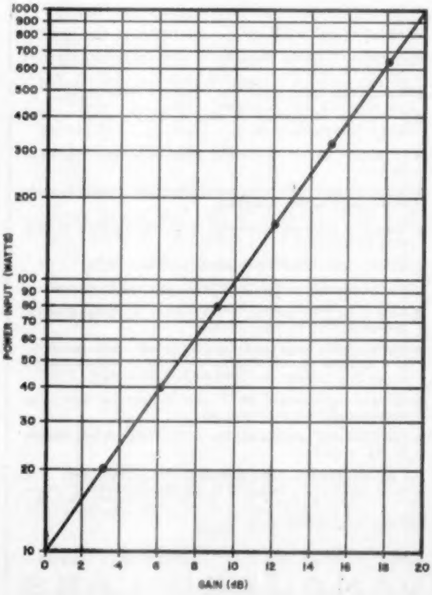
$$dB = 20 \log \frac{P_2}{P_1} \text{ for voltage}$$

Each has its use in amateur radio. However, the amateur not versed in mathematics and logarithms, when confronted with these formulas, usually backs off. Most hams, therefore, are content with the knowledge that an increase in the number of decibels is desirable and that a loss in the number of decibels is not.

This knowledge suffices for all practical purposes. However, considering the many times decibels are used in the operation of a station, it behooves the amateur to become more familiar with this elusive term. The amateur may consider increasing the power of his station or changing antennas. How many decibels will this change represent? Will it pay to increase transmitter power or install a more efficient antenna system? This article will help to answer these questions without the use of complex mathematics.

Decibels as such are not an absolute quantity. They refer to a change. This change expresses ratio whether it be current, voltage, or power. The ratio means nothing until some reference level is established. Once the reference is set this reference is considered zero (0) dB. For example, some communications engineers may use 6 milliwatts (.006 watt) as reference while others will use 1 milliwatt (.001 watt). The reference level or zero dB, when used in amateur radio, is whatever the amateur starts with.

For the purpose of illustration lets assume Joe Ham has a 10 watt rig which is operating under ideal conditions (no losses). It must be realized that there are always losses. However, for the purpose of facilitating the understanding of decibels all conditions will be considered ideal. The power input to the final (the 10 watts) is the reference level or zero db. Any station changes to increase power will be referred to this starting power. If the station was running a 100 or 1000 watt transmitter, this would be the 0 dB or refer-



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ence level.

Any contemplated change in the transmitter power will result in a change in decibels or a change in the power ratio. Joe ham decides to increase his power from 10 watts to 20 watts. What will the result be in decibels? Referring to Fig. 1 will disclose that the increase will be 3 dB. Observe that to obtain an additional 3 dB gain the 20 watts must be increased to 40 watts. Therefore, an important point to remember is: each time the power is doubled the gain is increased by 3 dB. Conversely a 3 dB loss reduces the power by ½. Knowing these facts any multiple of 3 dB can be calculated. Accordingly, let's see how this works out for an arbitrary value of 15 dB.

dB gain	0	3	6	9	12	15
watts	10	20	40	80	160	320

dB loss	0	3	6	9	12	15
watts	10	5	2.5	1.25	0.625	0.3125

In order to extend our ability to calculate dB's it will be advantageous to review some basic arthmatic. When a number is multiplied by 10 you affix a zero to the number. Multiplying by 100 you affix two zeros, etc. This is known as shifting the decimal. Dividing by any multiple of 10 moves the decimal in the opposite direction. The ability to shift the decimal is all that is required to be able to calculate decibels in multiples of 10.

Calculating decibels in multiples of 10 is simple if you consider the reference as 0 dB, if it is desired to determine the increase in power for 10 dBs we've changed the reference 0 to 10 by putting the digit 1 before the zero. Essentially this digit (1) tells you to add 1 zero to the reference. Therefore, the 10 watts with a 10 dB increase becomes 100 watts. For 20 dB the digit before the 0 is 2. This digit (2) tells you to add 2 zeros. The 10 watts with a 20 dB gain will become 1000 watts. In order to clarify this let's utilize this information to make a chart.

dB gain	0	10	20	30	40	50
watts	10	100	1000	10000	100000	1000000
Zeros added	0	1	2	3	4	5

To consider losses. It is best to consider that the digits before the zero indicates the number of places the decimal must be moved to the right. Observe the chart below.

dB loss	0	10	20	30	40	50
watts	10.	1.0	0.1	0.01	0.001	0.0001
Places decimal moves	0	1	2	3	4	5

Thus far we are able to calculate decibels in multiples of 3 dB and 10 dB. Combining these two facts with addition and subtraction we are now able to determine the gain or loss for any number of decibels. To ascertain that we do, we'll find the value for any number of decibels between 10 and 20 still using the original 10 watts as zero reference. Starting with 10 dB gain adds a zero to our reference, increasing the 10 watts to 100 watts. Each additional 3 dB gain doubles the power.

Decibels	0	10	13	16	19
watts	10	100	200	400	800

Now starting at 20 dB the 10 watts with two zeros becomes 1000 watts. Each 3 dB reduces the power ½.

Decibels	0	20	17	14	11
watts	10	1000	500	250	125

The only values we have not determined are values of decibels for 12, 15, and 18. These values are multiples of 3 and can be calculated by utilizing the method described previously.

The practical application of decibels in terms of power, can now dictate the advantages or disadvantages of station changes. Increasing transmitter power is a one way street. The old adage; you can't work what you can't hear is applicable. Therefore, when looking for db gains; travel the two way street via the antennas. Improving antenna capabilities increases the number of decibels in both the transmitted power and the received signal.

When antenna gain is specified by the manufacturer, the gain is based on what the beam will do in comparison to a dipole under the same conditions. If a beam rated at 8 dB gain is replaced by one having 15 dB the gain is 7 dB. Stacking antennas increases the gain 3 dB. Raising the antenna an additional 30 feet will result in a 10 dB gain. These facts are presented so that you can start using this method of calculating decibels in terms of power the easy way.

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Ed Marriner, W6BLZ
528 Colima Street
La Jolla, California

The Highflyer

An All-Band SSB-CW Receiver

This article is about a home-brew ham band receiver covering the 80-40 20-15 and 10 meter bands in 200 kHz tuning steps. Before discussing the receiver a few reflective thoughts are presented on the idea of home-brew construction in general.

Most amateurs should be able to build a receiver if they have the time, a few instruments and tools. Picking circuits to use out of the handbooks may not always work for a specific application, and it may be necessary to try several circuits before finding one that works right.

Home constructed gear probably has some faults but if you really take a close look at most manufactured gear there will be oscillator harmonics across spots in the dial, images and signals feeding through from other bands. A ham can do a comparable job and have a lot of fun building which should be part of our hobby.

Some people spend all of their time building intricate model ships, airplanes or play cards. I spend my time building impossible ham gear. Perhaps the urge to build is the desire to do something creative instead of just yakking on the microphone for a change. The fallacy that you have to be experienced to work out ham gear is wrong. Anyone can gain enough experience if they just work at building for a while, but they must build and try various circuits. Sometimes it helps to keep notes on the circuits tried, but I am always too busy to keep notes and find myself making the same mistakes over again. Fortunately I am clever at filling up chassis holes. After months of building and the unit is finished I may never turn it on again, but after completing this receiver I can't wait to get home and turn it on to marvel how well it works and that I was able to build it. It is a fine feeling that is not present turning on a manufactured receiver. Visitors stop in to listen, and this way hams from all over the world at one time or another come by the shack.

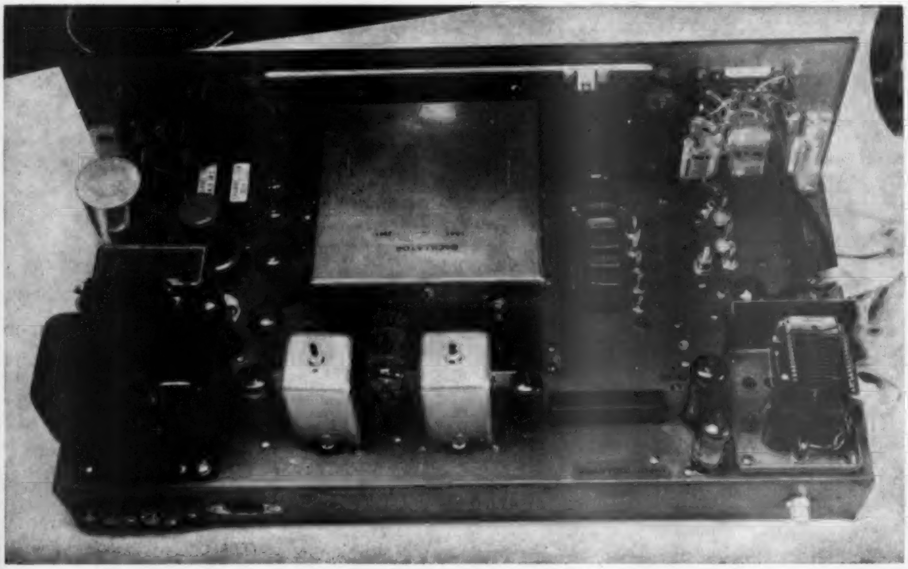
Besides personal contact one way amateurs can exchange circuits and transmit or expand his knowledge from generation to generation is through magazine articles. If amateurs don't take advantage of this and continue their mad pace to buy all manufactured equipment, our old concept of ham radio will have changed. Fortunately we have 73 Magazine as a medium to pass on information that is not staff written. One can read and does not always have to build the item in the article to gain some new idea. With this thought, the following receiver article is presented, and I hope someone has the time and a few bucks to buy the parts and give it a try.

Theory

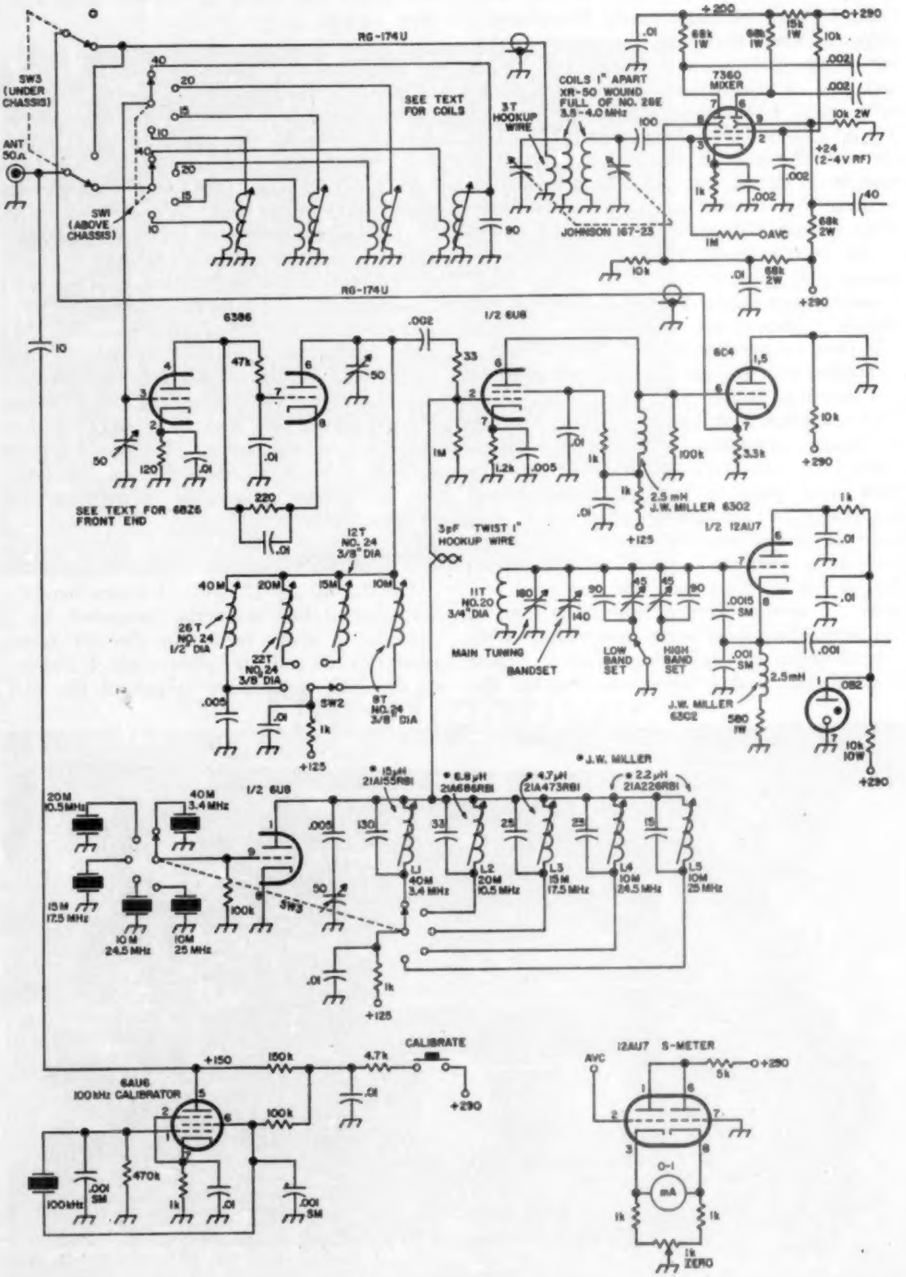
Basically this receiver is a simple 80 meter receiver into which converters are fed for the HF bands. On 80 meters the panel switch feeds the 52-ohm coax antenna input directly into the 7360 mixer input tube through two tuned circuits which are loosely coupled. This is necessary along with the shielding of these coils to prevent signals 455 kHz away, such as fishing boat frequencies, from coming in on the 80 meter ham band. A VFO signal of 3045-3345 kHz and 3345-3545 Khz is injected into the 7360 mixer tube. The mixed output of this tube is 455 kHz and is coupled directly into the Collins mechanical band pass filter. The signal is then amplified by two stages of *if* amplification controlled by AVC; then the amplified signal is detected in a product detector and audio amplified.

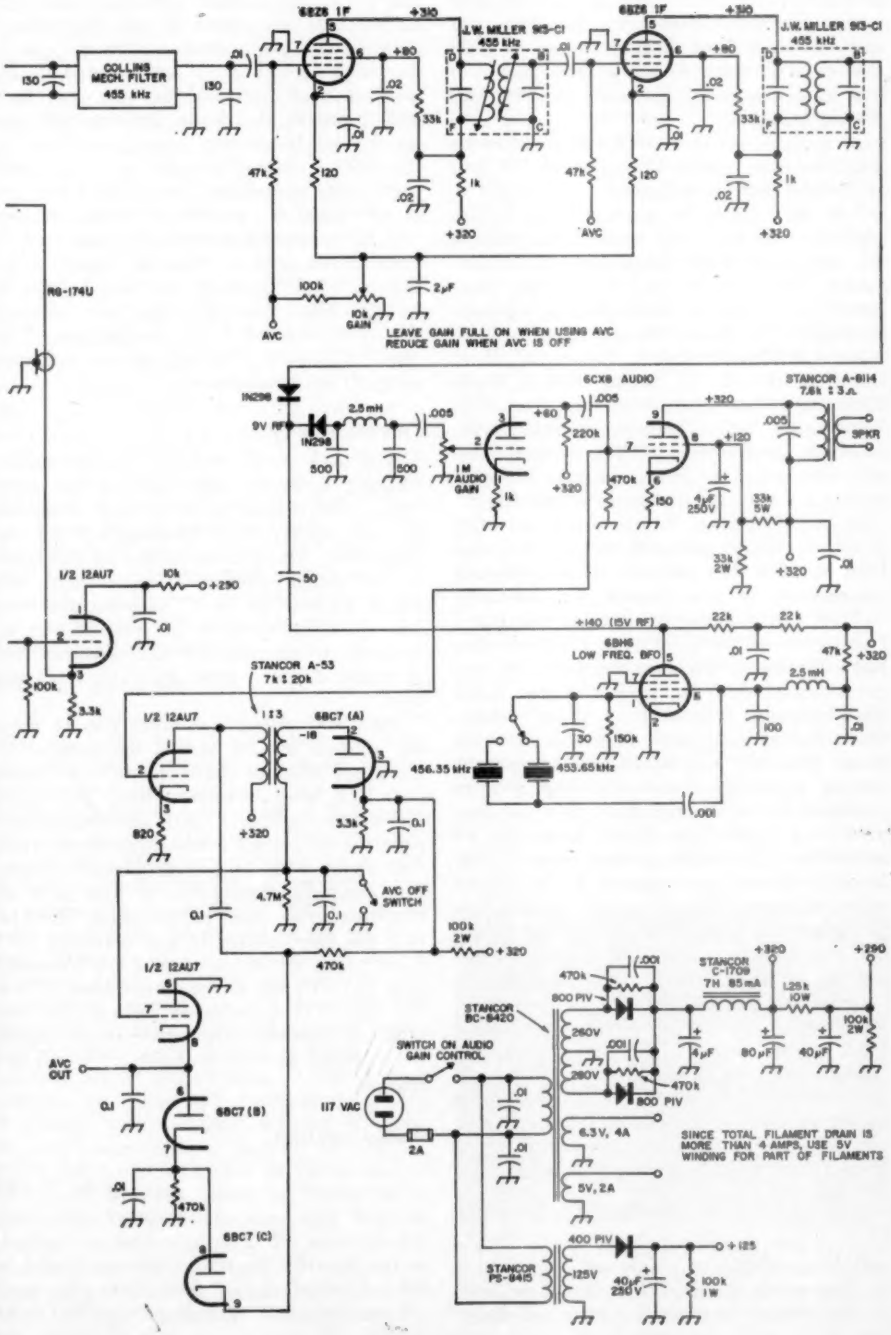
Construction

On the 40 20 15 and 10 meter bands a crystal-controlled converter preceded by a cascode rf stage feds into the 80 meter receiver via a cathode follower which matches to the high impedance output of the 6U8



Back view of the receiver showing input on the right side, mechanical filter, if strip, and power transformer on the left. The VFO is enclosed in the large box in the center of the receiver.


SW3 (UNDER CHASSIS)
ANT 50Ω
SW1 (ABOVE CHASSIS)
40
20
15
10
RG-174U
SEE TEXT FOR COILS
90
3T HOOKUP WIRE
COILS 1" APART XR-50 WOUND FULL OF NO. 28E 3.5-4.0 MHz
JOHNSON 167-23
100
+200
+290
.01
68k 1W
68k 1W
15k 1W
10k
.002
.002
7360 MIXER
10k 2W
+24 (2-4 V RF)
1k
.002
.002
40
68k 2W
1M
AVC
10k
.01
68k 2W
+290
10
6386
47k
50
.01
50
120
.01
220
.01
SEE TEXT FOR 6BZ6 FRONT END
.002
1/2 6U8
33
1M
1.2k
.005
.01
1k
100k
2.5 mH J.W. MILLER 6302
1k
.01
+125
6C4
1,5
10k
3.3k
+290
3pF TWIST 1" HOOKUP WIRE
12T NO. 24 3/8" DIA
40M
20M
15M
10M
26T NO. 24 1/2" DIA
22T NO. 24 3/8" DIA
8T NO. 24 3/8" DIA
.005
.01
SW2
1k
+125
11T NO.20 3/4" DIA
180
140
MAIN TUNING
BANDSET
90
45
45
90
LOW BAND SET
HIGH BAND SET
.0015 SM
.001 SM
1/2 12AU7
1k
.01
.01
.001
2.5mH
J.W. MILLER 6302
580 1W
0B2
10k 10W
+290
• J.W. MILLER
• 15μH 21A155RBI
• 6.8μH 21A686RBI
• 4.7μH 21A473RBI
• 2.2μH 21A226RBI
1/2 6U8
20M 10.5 MHz
40M 3.4 MHz
15M 17.5 MHz
10M 24.5 MHz
10M 25 MHz
100k
SW3
.005
50
130
33
25
25
15
L1 40M 3.4 MHz
L2 20M 10.5 MHz
L3 15M 17.5 MHz
L4 10M 24.5 MHz
L5 10M 25 MHz
.01
1k
+125
+150
150k
4.7k
CALIBRATE
.01
+290
6AU6 100kHz CALIBRATOR
100k
100kHz
.001 SM
470k
1k
.01
.001 SM
12AU7 S-METER
AVC
5k
+290
0-1
mA
1k
1k
1k ZERO


130
COLLINS MECH. FILTER 455 kHz
130
.01
6BZ6 IF
+310
J.W. MILLER 913-C1 455 kHz
+80
.02
33k
.01
47k
120
.02
1k
+320
6BZ6 IF
+310
J.W. MILLER 913-C1 455 kHz
+80
.02
33k
.01
47k
120
AVC
.02
1k
+320
2µF
100k
10k GAIN
AVC
RG-174U
1N298
9V RF
1N298
2.5mH
500
500
.005
1M AUDIO GAIN
6CX8 AUDIO
+60
.005
220k
+320
1k
470k
150
+320
+120
4µF 250V
STANCOR A-8114 7.6k : 3Ω
.005
SPKR
33k 5W
33k 2W
+320
.01
50
1/2 12AU7
10k
+290
.01
100k
3.3k
+140 (15V RF)
22k
22k
.01
47k
+320
6BH6 LOW FREQ. BFO
2.5mH
30
150k
100
.01
456.35 kHz
453.65 kHz
.001
STANCOR A-53 7k : 20k
1:3
1/2 12AU7
-18
6BC7 (A)
820
+320
3.3k
0.1
4.7M
0.1
AVC OFF SWITCH
0.1
100k 2W
+320
470k
1/2 12AU7
AVC OUT
0.1
6BC7 (B)
.01
470k
6BC7 (C)
STANCOR BC-8420
470k
.001
800 PIV
260V
260V
.001
470k
800 PIV
STANCOR C-1709 7H 85mA
+320
1.25k 10W
+290
4µF
80µF
40µF
100k 2W
SWITCH ON AUDIO GAIN CONTROL
117 VAC
2A
.01
.01
6.3V, 4A
5V, 2A
STANCOR PS-8415
125V
400 PIV
+125
40µF 250V
100k 1W

LEAVE GAIN FULL ON WHEN USING AVC
REDUCE GAIN WHEN AVC IS OFF

SINCE TOTAL FILAMENT DRAIN IS MORE THAN 4 AMPS, USE 5V WINDING FOR PART OF FILAMENTS converter plate circuit. The forty meter band tuning starts at 3600 kHz, this idea was used to keep from having to use a 3500 kHz crystal which would be annoying if it was operating on its harmonic of 7000 kHz during tuning.

The AVC uses the Luick system of audio amplified fast attack AVC, one of the best circuits for receiver design.

The most expensive parts are the Collins Mechanical filter, number F455-21-6626, a 2.1 kHz bandwidth filter costing $26 obtained directly from Mr. B. Cornes, Component Sales, Collins Radio Co., 19700 Jamboree Rd. P.O. Box C, Newport Beach, Calif. and the Eddystone dial #898 ordered direct from Mr. F. N. D. Harris, British Radio Electronics Ltd, 1742 Wisconsin Ave. NW, Washington, D.C. These two pieces are the heart of the receiver; after making the decision to purchase them the next thing is to buy a 8 x 17 x 2 inches California Chassis type A-109 and a PA-14, 8¾ x 19 inch panel. I cut my panel down to 6½ inches high by 17 inches long for a more pleasing appearance. A few shields are necessary and 16 gauge aluminum can be bent in a vise with two blocks of wood or maybe you know someone with a hobby brake or can get a metal shop to do it for you. LMB boxes can also be sawed up to get shields. Once the major portion of the holes have been punched a professional appearance can be given the chassis by dipping it in chemical dye obtained from a chemical supply house under the trade name Oakite metal dye. The chassis is first cleaned with lacquer thinner and dipped in lye water which is warm. This cleans the metal. This is washed off and dipped in Oakite bright dip and washed again. The chassis is then put in the Oakite gold metal dye for 15 minutes and washed off. Plastic containers for dipping can be bought in the Super-Markets.

Metal working requires a few tools. A ⅝ inch, a ¾ inch, and a 1⅛ inch Greenlee punch are almost necessities. A clear drill for 4-40 and 6-32 screws and a ¼ inch, ⅜ inch and ½ inch bit for metal are also needed.

Probably the first electrical circuit to build is the power supply so that voltages will be available to check out the circuits as they are built. The VFO should be built on the chassis next so that you will know how much available space is left to lay out the parts. Next after the VFO, wire the audio stage and check it out, then the *if* system. The grid return to the *if's* can be grounded to test it out since the AVC has not yet been built. Along with the audio and *if* put in the diode detector and wire up the low frequency crystal oscillator for the BFO. When this is finished a 455 kHz signal can be fed into the *if* front end and detected and *if's* peaked up. If the mechanical filter has not arrived that spot can be jumped out with a .005 μF capacitor between the 7360 mixer and the *if* tube for testing. After the 7360 has been wired in the AVC can be built, leaving the VHF converters until the receiver is operating correctly on 80 meters.

Power supply

The load on the 6.3 V, 4 amp filament winding is heavy and some of the tubes such as the crystal oscillators and others can be run off the 5 V winding without any bad effect. The extreme drain on this transformer might warrant using a larger one but as an assist to the HF isolation the drain was eased by using a 125 volt 15 mA instrument transformer for the converter and *rf* stage. Stancor type PS-8415 was used here.

Two 400 piv diodes were put in series for rectifiers in each arm of the transformer. They are cheaper than diodes with higher piv's. To keep transients from puncturing the diode rectifier a .001 μF disc ceramic capacitor is placed across each diode rectifier along with a 470 k ½ watt resistor. For complete elimination of hum a 4 μF condenser was used as an input filter before the filter choke. It was necessary with a large loud speaker with good low frequency response to keep it free from hum. Power for the VFO is obtained from a 105 volt OB2 gas regulator. The series resistor should be adjusted so that at least 10 to 15 mA does it.

Audio system

The audio system uses one tube which gives plenty of audio gain. If the audio is weak is is not the fault of this stage which is a 6CX8 triode and a pentode in one bottle. The screen voltage should be held constant at not over 150 volts by a voltage divider. Our voltage was 120 volts. A .005 μF capacitor is placed across the primary of the audio transformer to prevent self oscillation from building up and damaging the audio transformer winding insulation or to prevent arcing from occuring across the tube socket pins.

By now you will need some knobs to adjust controls. The fancy knobs used on this set were Davies type 1913 black knobs with white indicator lines. They will have to be ordered from Littrell Western Sales, Inc., P.O. Box 23645, 3121 East Twelfth St, Los Angeles, Calif. 90023, attn. Mr. M. Morita. Radio parts stores do not seem to stock anything out of the ordinary and it's worth the effort to get these and make the receiver look better.

The triode portion of the tube normally uses a 150-ohm resistor but in this instance there was so much gain the current was reduced by inserting a 1000 ohm resistor.

Shielded wire such as RG-174U was used to wire the gain control on the panel. Just ahead of the triode tube is a filter made up of two 500 pF capacitors and a 2.5 mH rfc. This filter prevents any 455 kHz signal from feeding into the audio system. A 68 k resistor could be used in place of the choke but the cut-off characteristics of the filter will be changed slightly.

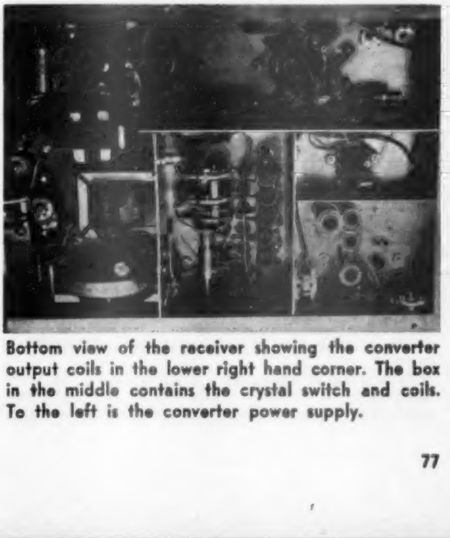
Product detector

Of all the various product detector circuits tried this two diode circuit performs as well as any, however, germanium diodes must be used. Just any diode won't work. The diode used has to have a lot of leakage to prevent charging up and blocking. The 1N295 or 1N67A are common ones used in this circuit. For loud signals proper mixing is secured in these diodes with 5 to 12 volts of rf from the crystal oscillator. Anything under 5 volts will sound distorted if a strong signal is being received but will sound okay on weak signals. Injection was measured by using a signal generator and varying the diode injection voltage and listening to its performance at the various voltages for weak and strong signals. This rf voltage was measured with an rf probe in conjunction with a Heathkit VTVM.

The if strip

The first thing to do when building the *if* strip is to open up the *if* can and squeeze the coils to within ⅛ inch of each other. This operation is not recommended by the J. W. Miller Co. because the coil now becomes overcoupled and might be a reflection on their product if it gets into wrong hands. I reasoned that I needed the extra gain to make up for the loss in the mechanical filter, and I did not want to add another if tube. Since the selectivity was obtained in the filter it was felt that the ultimate in selectivity was not needed from the *if* cans. Squeezing the coils together is difficult to accomplish without damaging them. Bill Courtney at the J. W. Miller Co. would rather wind the coils for you than have you damage them. If you already have coils, take a razor blade and scrape the glyptol from each side of them on the top coil only where it is glued to the fibre form. Now with a camel hair brush paint dope thinner around the base of the coil to soften up the cement under the wire. Next place a piece of ⅛ inch thick wood between the coil by first drilling out a ¼" hole and sawing the block in two parts so that it fits snuggly around the fibre tube. Take another piece of wood with a ¼ inch hole and slip it over the fibre tube after the slug has been removed. With a quick snap the coil should slide up against the wood between them leaving the coils ½ inch apart. Do not try this process without using the spacer because the wire will come out from inside of the coil.

Many hams have trouble trying to build an *if* amplifier without oscillation or regeneration taking place. First all parts should be returned to one ground lug on each *if* tube, although it never seems to help the problem. In most cases a 22 k or 47 k resistor can be put across the winding of the *if* transformer to stop oscillation or



Bottom view of the receiver showing the converter output coils in the lower right hand corner. The box in the middle contains the crystal switch and coils. To the left is the converter power supply.

by tapping down on the secondary winding for the grid. Most military receivers do this and the Miller has tapped coils for this purpose. Many commercial builders increase the 6BZ6 cathode resistor to 120 ohms to cut down on the gain. I found building this receiver the stage is absolutely cool by reducing the series resistor to the AVC line to 47k in conjunction with squeezing the coils together which lowers the "Q" the grid is looking into. No resistors were needed across the coils and we were quite happy to find no regeneration when peaking the if cans in this receiver. Good decoupling with 1 k resistors and .01 μF capacitors in the supply leads also help to isolate feedback.

7360 mixer stage

This tube was chosen because it eliminates the need for an rf stage and takes large input signals. It is linear and performs mixing by switching between two output plates operating in push pull and is inherently balanced against the input signal frequencies. The oscillator injection voltage can be anything from 1 to 10 volts. The tube does have some critical aspects in transmitters where the accellerator voltage changing can unbalance the carrier. In receivers, this is not critical except that proper voltages should be used. There must be 175 volts on the screen or accellerator and 20 to 25 volts on the deflection plates. The main supply to the tube should be set at 200 volts to give 150 volts on the plates. The voltage actually came out a little higher in this receiver. The tube couples easily into the mechanical filter via the .002 μF capacitors.

Reference data on the cross-modulation and overload characterics can be found in QST.[1]

VFO injection to the mixer is not critical. One to five volts is satisfactory. Since there is no rf tube ahead of the 7360 adjacent signals 455 kHz away in the marine band might feed in if they are not attenuated by a good shielded front end coil. 80 meters is the only band we have to worry about this because the image is 3.5 MHz away using the converters on the other bands. To gain this good selectivity on 80 meters a large coil could be used, but that takes up a lot of room. It was found two XR-50 National slug forms wound full with number 26 wire and tuned with a split stator capacitor make a good filter. The coils were placed adjacent to each other and peaked up to the capacitor and moved away from each other to about one inch where the double hump effect went away and left a nice sharp tuned circuit. The image should be down 60 dB. The coils were placed in a box to prevent any pick up of signals by themselves. Any split-stator capacitor could be used but the E. F. Johnson butterfly type dual #167-23, 50 pF each section took up little space. It was necessary to shunt another 40 pF across each section so that it would tune the 80 meter band, which can be set in the middle of the condenser range by adjusting the slugs to maximum signal strength.

AVC was used on the 7360 to good advantage since it limits the signal going into the mechanical filter, which would over load and ring if the signal peaks were too high.

AVC system

The receiver should be tried out before hooking on the AVC system by grounding all of the if and 7360 grid resistors. Once the AVC system is hooked on there should be a negative AVC voltage of 0-20 volts. The Luick AVC system was chosen for this receiver after having used several systems in other receivers. It works the best for fast attack and slow decay. The hold-up time is set by the o.1 μF capacitor and 4.7 MΩ resistor. If this resistor is made smaller VOX operated SSB stations will make the receiver pump and sound funny. This value can be lowered for CW but so far there has been no need for it.

The AVC voltage is taken off the product detector and is amplified by a triode tube, then rectified and passed on through another diode to charge up the storage capacitor, a 0.1 μF capacitor, which stays charged until discharged to ground by the other triode tube. A strong audio signal provides a negative voltage of 0-20 to control the if's and 7360 tubes. When there is no audio signal coming, the grid of the triode goes positive and allows the charge on the capacitor to leak off to ground. This grid control is also effected by the

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[1] A New Approach to Receiver Front-End Design, p. 31 Sept. 1963 QST.
Cross-Modulation in the 7360, p. 58 June 1964 QST.
The Squire-Sanders SS-1R Receiver, p. 54 May 1964 QST.
7360 Mixers in the 75A-4 p. 18 July 1964 QST.

0.1 μF and the 4.7 MΩ resistor. For faster or slower leak off the value of this resistor can be increased or decreased, changing the time the voltage will be stored and the 0.1 μF holds the triode off. A discussion of this circuit is in the ARRL Handbook, if you have trouble.

"S" Meter

The "S" meter can be taken off from the AVC line and it will be a measure of the AVC voltage. Zero level can be set with no signal and by adjusting the balance potentiometer. The scale reading was adjusted for a strong signal at R-9 by changing the value of the cathode resistors. Maximum reading can be set by either adjusting these cathode resistors or by changing to higher gain tubes such as the 12AT7, or 12AX7 if the 12AU7 has to low a gain and you don't want to fuss with the resistors. It is important to use *no* grid return resistor on the tube where the meter is attached to the AVC line or it will upset the time constant of the AVC action. Thus you will note no grid resistor is used in this circuit.

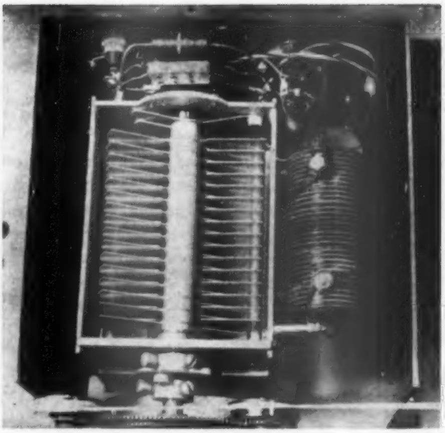
Tuning of a signal produces a negative voltage on the AVC line which causes currents in the cathodes of the "S" meter amplifier to unbalance the circuit. The meter will read the unbalanced or difference voltage. The resistor in series with the tube plates can also be adjusted larger or smaller depending on the meter readings.

The "S" meter is a Lafayette Model 99-2514, 0-1 mA with illumination. Instructions for lamp connection is inside the box.

VFO

The VFO oscillator tunes both 3045 to 3265 kHz and 3315 to 3545 kHz, using the surplus ARC-5, 180 pF capacitor. Tuning barely covers the band. The ham bands are covered in two steps of about 250 kHz each. The oscillator was switched with a three position switch. The third section uses no padders and covers 4000 to 4200 kHz. The trimmer on band two was set so that the dial matched 3720 on zero and 3500 on band one.

A cathode follower was used after the VFO to separate any loading effect on the oscillator. All signals are carried via RG-174U coax. The coil was bolted to the capacitor so that there would be no mechanical motion. The tube is mounted in a horizontal position on the back of the box. Calibration should be done with the cover bolted in place. With an LM frequency meter the calibration is easy. Otherwise someone on the air with a Collins transmitter could give calibration marks or surplus crystals could be used for check points. The rf output to the mixer can be varied by changing the 40 pF capacitor in series with the cathode follower output. Anything between 2-4 or six volts will be satisfactory for injection. When the VFO was finished the coil was doped with Q dope, although, the wire was wound in grooves. Air-Dux bulk coil could be used if no fibre forms are available.


The inside of the VFO box assembly.

This circuit is so swamped with high capacitance that the stability of the circuit is very good, and there does not seem to be any drift problem noticed. Use silver mica capacitors in the tuned circuits in conjunction with the air capacitors.

Low frequency oscillator

Many low frequency crystal oscillator circuits were tried using surplus crystals ground to 453.650 and 456.350 kHz. The only circuit which worked satisfactorily is the one shown in the schematic. Perhaps the wave form on the oscillator plate with no tuned circuit leaves much to be desired for a perfect sine wave, however, the frequency is correct, and it is satisfactory for the product detector injection.

Sluggish low frequency crystals need a large rf choke in the screen lead, and most circuits use a 60 mH choke. This circuit worked with a 2.5 mH choke taking up less space. Sometimes the 30 pF capacitor from grid to ground may have to be varied to obtain oscillator but not the 100 pF from the screen to ground.

New crystals can be bought from Mr. P. M. Freeman at International Crystal, 18 North Lee St., Oklahoma City, Okla., ground to 453.650 and 456.350 exactly but they cost $8.00 each. It is important to have these crystals as close to these values as possible so that the band-width of the receiver is 2.7 kHz wide at the 20 dB down points. Otherwise the voice signals will sound distorted.

The other solution for the proper crystal is to buy surplus crystals and edge-sand them down to frequency. JAN*, which advertises in 73 Magazine, sells these crystals for 50 cents each. A channel 45 and a channel 329 will work but sound a little funny. If you're brave, buy a handful and sand them down, tuning the receiver until they sound good. The best way would be to check the frequency with a counter.

Changing the frequency can be done as follows:

Put a piece of fine emery paper on a flat surface and tape it down. Place the crystal in the left hand holding the prongs with the fingers of the left hand, and holding the crystal itself with tweezers in the right hand. Draw the crystal edge toward you moving both hands together making a scratch about five inches long. Drag the crystal across the paper about ten times and it will move it about 600 Hz higher in frequency. This process is very touchy and if the tweezer slips, the crystal will twist and break the fine wire, it might pay to take the time and make a wooden holder from a clothes pin or two pieces of wood, but it can be done.

The following are surplus crystal channels:

Channel 326 - 452.777
Channel 45 - 453.707
Channel 327 - 453.166
Channel 46 - 455.555
Channel 329 - 456.944
Channel 47 - 457.407

I suppose other methods could be used to vary the crystal frequency. Shunting capacitors across the crystal never worked very good and did not change the frequency enough. With patience you can get the Channel 327 and Channel 46 on the spot. You can get an idea what a crystal off frequency sounds like by plugging in some of the above mentioned crystals.

The HF Crystal Oscillator

It is recommended that the International crystals of .01% tolerence be used in this oscillator so that the dial calibration will be on the mark. International FA-9 crystal fits into a FT-243 crystal socket. All of the crystals will oscillate in a standard triode oscillator with a tuned plate tank, although the output may fall off slightly at the higher frequencies. It is difficult to specify the exact value of the slug coil and tuning capacitor to use with each coil because the lead length will be different used by each constructor. Tuning is critical. These coils can be grid-dipped with the meter when they are all in place and then adjusted for capacity after applying power and noting where the slug comes to rest. The slug should be set just back of maximum output because the oscillation will drop out if too near maximum tuning. An rf probe can be used to peak up these coils or a full scale meter section of the grid-dipper. Using the probe a test point can be put in the chassis and coupled to the coils with a 10 pF capacitor to make it easy.

	Crystal	Coil J. W. Miller	Tuned by Silver Mica
40 meters	3200	21A155RBI—15 μH	130 pF
20 meters	10,500	21A68RBI— 6.8 μH	33 pF
15 meters	17,500	21A473RBI— 4.7 μH	25 pH
10 meters	24,500	21A226RBI— 2.2 μH	15 pF
10 meters	25,000	21A226RBI— 2.2 μH	15 pF

VHF Converter

You can wind your own coils using #26 wire if desired. XR-50 forms are nice if you have room.

This section which looked to be the most simple turned out to be the most difficult part to make work properly. The first try used a 7360 but it was necessary without the rf stage and output coils to use a high Q coil circuit. The coil being so large picked up 80 meter signals like an antenna and fed in the 80 meter signals on all bands. To prevent this an rf stage was added and the 7360 replaced with a 6U8 mixer. Reducing the size of the coils and shielding them stopped the pick-up and prevented oscillation from occuring. To further prevent coupling a separate power supply was used for this section and it was needed anyway because of the overloaded power transformer on the rest of the receiver.

On the upper deck of the receiver was installed a switch to change the input coils to the rf stage. Oscillations could not be stopped when all of the switches were ganged together. The coil dimensions are as follows:

40 Meters—¾ inch dia., 15 turns, Link, 6 turns. Air-Dux Bulk Coil #632

20 Meters—¾ inch dia., 11 turns, Link, 4 turns. Air-Dux Bulk Coil #616

15 Meters—⅝ inch dia., 8 turns. Link, 3 turns. Air Dux Bulk Coil #516

10 Meters—⅝ inch dia., 6 turns. Link, 2 turns. Air Dux Bulk Coil #516

These coils were mounted on five lug terminals, with the ten meter coil just soldered across the Centralab ceramic wafer switch, a double pole six position switch, Type PA3.

The output coils of the cascode converter are the grid input to the converter, and are separated from the converter grid by a shield. The 33 ohm resistor in series with the grid helps prevent overloading.

The output coils are as follows:

40 meters: 26 turns en. #24 wire wound on a ½ inch slug coil form.

20 meters: 22 turns en. #24 wire wound on a ⅜ inch slug coil form.

15 meters: 12 turns en. #24 wire wound on a ⅜ inch slug coil form.

10 meters: 8 turns en. #24 wire wound on a ⅜ inch slug coil form.

Coils are all grid dipped and adjusted in the circuit

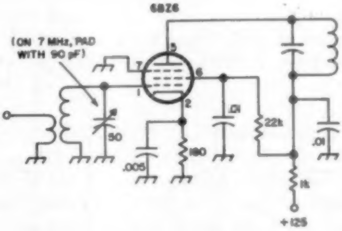
The XR-50 coil forms can be used if desired but the smaller coil forms fit better taking up less space. The 50 pF variable capacitor completes it circuit through a .005 μF capacitor between the bottom of the coils and ground lug. The switch for these coils is located underneath the chassis. This switch is used by itself, the other half is not used. The switch for shifting the converter output to the cathode follower is under the chassis and is part of the crystal switching switch.

RF Stage

The rf stage is one of the most difficult things to build in a receiver. Any type of coupling between the grid and plate brings on oscillation. The rf stage should not oscillate when the antenna is disconnected from the set, and the input and output tuning capacitors are tuned. For complete separation the antenna input coils should be mounted on top of the chassis in a box if possible while the output coils are mounted underneath. The grid should have a piece of tin cut from a coffee can around the grid pin, which can be soldered to the center shield of the socket. Put the feedthrough insulator right at the grid pin. Shield the output coils from the grid if possible.

Generally 40 meters will oscillate while the other bands are clean. This is due to insufficient capacitance tuning on that coil. A 90 pF capacitor was soldered across the coil and turns peeled off so that the variable would peak it to 40 meters. This is done with the antenna on because it will add some capacitance to the tuned circuit and which will be different than when it is taken off.

The 6386 cascode tube is expensive and may not be desired by some constructors. An alternate circuit using the 6BZ6 is shown. The coils are the same. Actually on the lower bands no difference was really noted between the two circuits as far as sensitivity or noise was concerned. The 6BZ6 gives a little more gain which is needed on the ten meter band.



Alternate rf amplifier that can be used in place of the 6386 tube. The same coil arrangement can be used. Put a shield around the grid.

Conclusion

The average amateur with a few tools and a VTVM and a grid-dip meter can have a lot of fun building this receiver. The receiver seems to work about as well as almost any on the market although it may take a few more switches to accomplish the band changing.

If you are in the area on your vacation and want to listen for yourself stop by. Just come in the back gate, and don't mind that madman running around in the backyard in shorts, barefoot, no shirt, hair uncombed, glasses down on the end of his nose, and waving a soldering iron. That's me, off on another construction project.

. . . W6BLZ

Henry Bradford
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Fairfax, Va. 22030

Geometric Circuit Design

A simple way to design electronic circuits is with geometry. This method avoids complicated math, yet is very versatile.

Over some years I have developed and have been using a new technique in circuit design. It is mainly graphic being based on geometry and avoids the abstractions found in complex algebra and many other forms of mathematics. The technique is deceptively simple and is based on only five basic concepts. Three of them are probably already known by circuit design people at every level. The other two are new and are needed to complete the design picture. These basic layouts are shown in Fig. 1.

At (a) two resistors are added in series. The same can be done with two or more inductive reactances on the XL axis or with two or more capacitive reactances on the Xc axis. At (b) we have the fimiliar parallelogram which shows the impedance formed by an inductive reactance X1 and a resitor R1 in series. Likewise the same can be done with

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Henry, ex-W3AUE, is an electronic project engineer for Fairchild Hiller. He was licensed in the '20's.

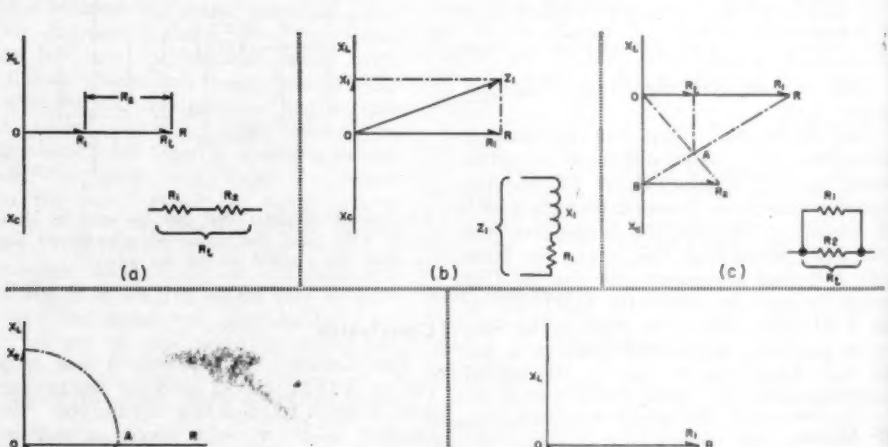

Fig. 1. Examples of geometric circuit design. Resistances are plotted on the horizontal axis marked R, capacitive reactances on the lower vertical axis, and inductive reactances on the upper vertical axis. (a) shows two resistors in series. (b) shows the impedance formed by a resistors and inductance is series. (c) shows the resistance of two parallel resistors. (d) illustrates a capacitor and coil in parallel. (e) shows a resistor and capacitor in parallel.

any Xc ar R or in fact any two impedances in series. The total value of any two resistors in parallel or any two like reactances can be found by the means shown in (c) of Fig. 1. While this one shows the R axis the same can be done with either other axis. Distance O-B is arbitrary and intercept A of the diagonal is projected up to find Rt. In **Fig. 1** (d) a simple method of finding the parallel value of two opposite reactances. With the value of X2 as a radius, an arc is laid out to the R axis. At the intercept A a straight line is connected to X1. A 45 degree line is extended from the origin (O) as shown. At intercept B a line is projected horizontally to the X axis locating the resultant total reactance Xt. In any case the arc is constructed from the larger of the two reactances. Finally in **Fig. 1** (e) there is shown the resulting impedance of R1 in parallel with X1. Here again this can be done similarly with any R and XL values.

It must be realized that any of these techniques can be worked in reverse that is if we have Rt and R2 in **Fig. 1** (a) we can find R1. Likewise at (b) if we know Z1 and R1 we can easily find X1. In any case if we have any two we can find the third by these simple geometric layouts.

Armed with these concepts we can now "jump off at the deep end of the pool" and emerge with meaningfull answers. Let's design a band pass "T" type filter to match 50 ohms to 200 ohms. Its schematic and layout is shown in **Fig. 2**. A scale of 50 ohms per centimeter* was used here and Rl is thus 1 cm long and R2 being 200 ohms is 4 cm long from the origin. We select X1 arbitrary and find Z1 immediately (see **Fig. 1** (b). Z1 has equivalent shunt components Xh and Rh (See **Fig.** 1 (e). Since X2 depends on the value of X3 we cannot find it before we find X3 which we can find. Since Z1 and Z2 have the same equivalent shunt resistance Rh, a locus semicircle O to Rh has been drawn. This passes through both Z1 and Z2. Z2 is established simply by projecting vertically up from R2. See **Fig. 1 (b)**. Now Z2 has equivalent components Xt and Rh which are in parallel. Again refer to **Fig. 1 (e)**. Some reactance value X2 in shunt with Xt must form Xh. We find the value of X2 by projecting horizontally from Xh to the 45 degree line intercept B. We then project from Xt through B to A and draw an arc from A to

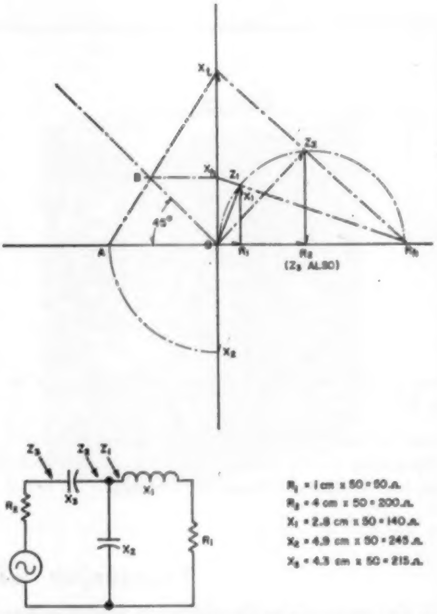

Fig. 2. Designing a band pass T filter to match 50 ohms to 200 ohms. The procedure is described in the text.

X2 about the origin. This establishes the value of X2. This geometry is performed on the left of the X axis to avoid confusion. This derives from **Fig. 1 (d)** working backwards. From the values Xt and Xh we have found X2.

Continuing X1, X2, and X3 are measured in cm and multiplied by the scale factor (50 ohms pre cm). Values of each in ohms is shown in **Fig. 2**. If the design is for 27 MHz the component values are about 0.82µH for X1, 24 pF for X2 and 32 pF for X3. Components for any frequency desired can be found which will match these two resistances and deliver maximum power from one to the other.

Since we have a picture of all of the components and impedances in polar form it is possible to analyze or synthesize any complex circuit for phase shift, attenuation (voltage or current) and Q. With the value of Q we can determine the bandwidth.

The simplest way to match one transistor to another at a specified frequency is by means of an "L" filter. In **Fig. 3** the schematic and layout are shown. Neglecting the distributed parameters we assume the in-

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*These drawings are reproduced ½ size.

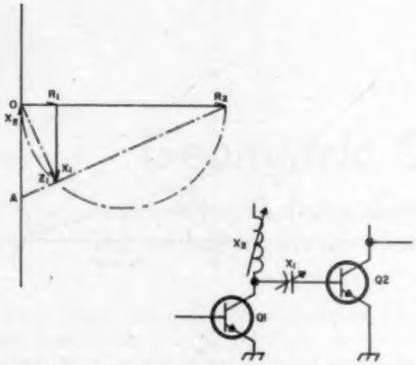


Fig. 3. Matching one transistor to another with an L filter.

put resistance of Q2 to be R1 and the output resistance of Q1 to be R2. These values must be found at the frequency desired. The locus circle with diameter O-R2 simplifies the construction of Z1 at right angles to the construction line R2-Z1, implementing the concept of **Fig. 1 (e)**. In series with R1 we drop a perpendicular to the semicircle. This establishes Z1 that is the impedance looking from Q1 thru X1 into the input of Q2. X2 extends upward from A to the origin. This is the reactance across R2 necessary to form Z1. Components can be evaluated as described above for 455 kHz or 50 MHz or any other frequency. Known distributed parameters are taken into account by adding them into the layout in the manner set forth in **Fig. 1.**

This technique can be extended to include the design or synthesis of delay lines transmission lines, "10" and "hi" pass filters, all coupling networks, and many mesh and bridge circuits.

. . . Bradford

Transceive with the GSB-201

The manual on the GSB-201 suggests another relay to operate it on transceive. Here is a way to do it with but adding a small transformer and rewiring a few parts. Thrown in is a cut-off bias supply for the amplifier in standby.

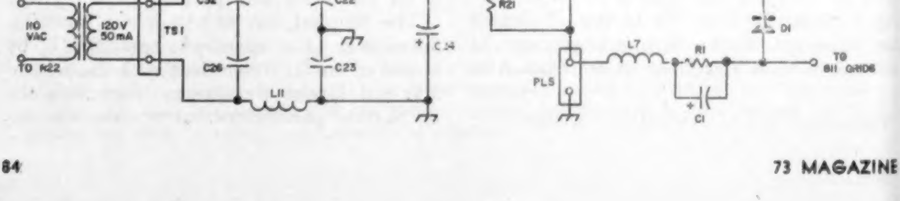
Modify the circuit as follows. Locate and reverse the D3 diode and C24 capacitor as shown. Remove the lead going to K1 from the junction of L11C23, C24. Ground the latter. Connect the lead going to K1 just removed to ungrounded side of PL5. Rewire K1 relay contacts as shown using R6G58 coax where needed. Add small transformer to circuit by connecting it to TS1 and primary to AC at DL1 and R22.

Be sure and put tape over TS1 on outside to prevent shock. Remove R21 only if you desire to speed up K1 operation. If this is done reduce value of C24.

Now we do all our switching by connecting relay contacts of transceiver to PL5. We find we have gained a built-in cut off bias supply. And by grounding this at PL5 we cause K1 to operate and cut amplifier into the cht. To disable amplifier and run transceiver only throw S1 to off in amplifier.

Caution should be observed to keep leads short and well shielded. In my own amplifier I found no instability after this modification.

. . . Bruce Walther W9QAH



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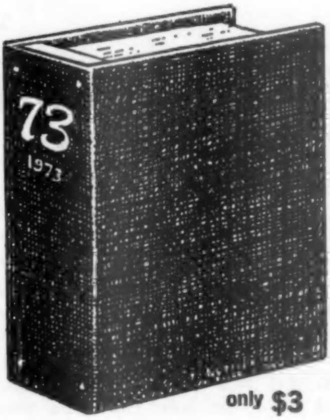

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Sam Creason K6DQI
4140 Diego Way
Rocklin, Calif.

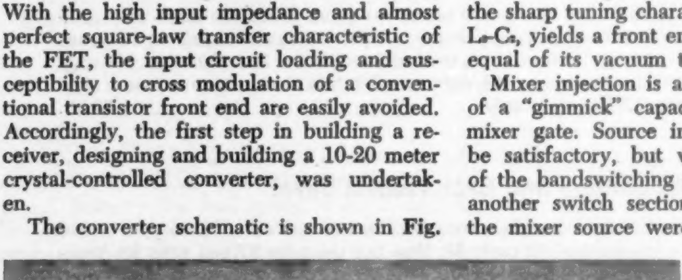
A Field Effect Transistor Converter for 10, 15 and 20 Meters

It is the author's goal to build a completely transistorized 10–160 Meter station. Lack of a low priced rf power transistor has postponed construction of the transmitter and, until recently, construction of the receiver was not attempted since it was felt that a vacuum tube front end was superior to any transistorized front end the author was capable of building. The availability of reasonably priced field effect transistors has changed the latter situation. With the high input impedance and almost perfect square-law transfer characteristic of the FET, the input circuit loading and susceptibility to cross modulation of a conventional transistor front end are easily avoided. Accordingly, the first step in building a receiver, designing and building a 10-20 meter crystal-controlled converter, was undertaken.

The converter schematic is shown in Fig. 1. Motorola 2N4224 FET's are used as the rf amplifier and mixer, while a bipolar 2N1180 is used as a transistor oscillator. A pair of Motorola MPF105's could probably be substituted for the 2N4224's, at a third of the cost, but this has not yet been tried.

The rf amplifier is designed to provide only enough gain to override any noise generated in the converter, so as to minimize susceptibility to cross modulation. This small amount of amplification, in conjunction with the sharp tuning characteristics of L_1-C_1 and L_2-C_2, yields a front end that is every bit the equal of its vacuum tube counterpart.

Mixer injection is accomplished by means of a "gimmick" capacitor connected to the mixer gate. Source injection was found to be satisfactory, but was not used because of the bandswitching problem it introduced: another switch section and a long lead to the mixer source were required. Source in-



Top view of the converter. Note that the input circuit is shielded. Photo by Chuck Marshall.

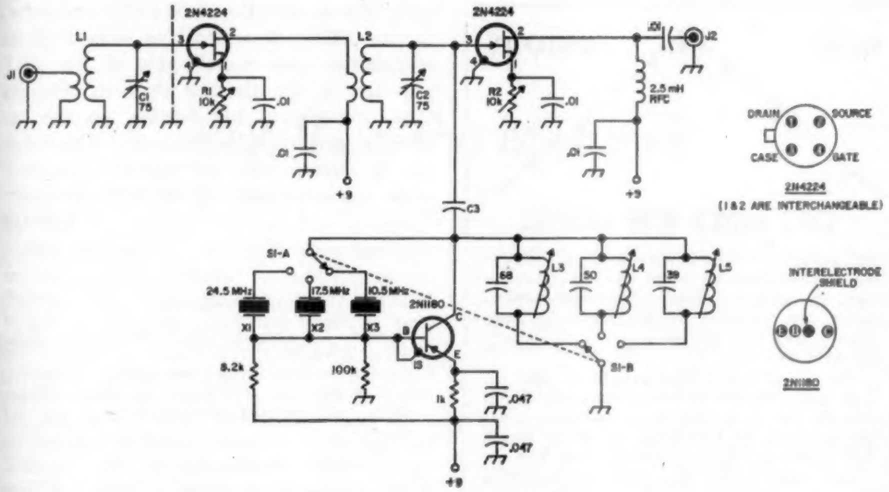

2N4224
L1
J1
C1 75
R1 10k
.01
L2
C2 75
+9
2N4224
R2 10k
.01
J2
2.5 mH RFC
+9
DRAIN
SOURCE
CASE
GATE
2N4224
(1 & 2 ARE INTERCHANGEABLE)
C3
S1-A
24.5 MHz
17.5 MHz
10.5 MHz
X1
X2
X3
2N1180
B
C
E
IS
8.2k
100k
1k
.047
.047
+9
68
50
39
L3
L4
L5
S1-B
INTERELECTRODE SHIELD
2N1180

Fig. 1. Schematic diagram of the FET converter for 20, 15 and 10 meters.

jection would be preferable if local oscillator radiation proved to be a problem, since it places two FET's between the oscillator and antenna rather than one, as is the case when gate injection is used. (The reverse transfer capacitance of the 2N4224 is 2 pF compared to a grid-plate capacitance of 0.02 pF for the 6BZ6 pentode, a common rf amplifier.) A suitable cource injection circuit is shown in Fig 2 for those who may prefer it.

The oscillator circuit was borrowed from another article[1] and is conventional in design.

Adjustment

After the converter is completed, connect it to an antenna and an 80 Meter receiver. DO NOT CONNECT THE POWER SOURCE UNTIL ALL TRANSISTORS ARE IN THEIR SOCKETS. Set the bias pots, R_1 and R_2 to mid-range and place S_1 in the 20 meter position. Then adjust L_3, C_1, and C_2 for a peak in 20 meter signal strength. As the receiver is tuned across the band, C_1 and C_2 will have to be re-peaked every 25 kHz. or so. Place the converter in operation on 15 and 10 meters in a similar fashion. Adjust the bias pots for best converter operation, after which they may be replaced with fixed resistors or wired permanently into the circuit.

Parts List

C_3—Two 1-inch lengths of insulated hookup wire twisted together.

L_1—Primary, 12 turn No. 20, 16 t.p.i., ¾-inch diam. (B&W 3011), Secondary, 3 turns No. 20, 16 t.p.i., ¾-inch diam. spaced 1 turn from primary.

L_2—Primary, as L_1, Secondary, 3½ turns insulated hookup wire wound on cold end of primary.

L_3—35 turns No. 30 enam. wire, close-wound on ¼-inch diam. iron-slug form (Miller 20A000RBI useable).

L_4—25 turns No. 30 enam. wire, close-wound on same type form as L_3.

L_5—15 turns No. 30 enam. wire, close-wound on same type form as L_3.

Results

The results to date have been pleasing. Although the converter has not seen much use on 10 meters, it appears to work well on that band. On 15 and 20 meters it easily

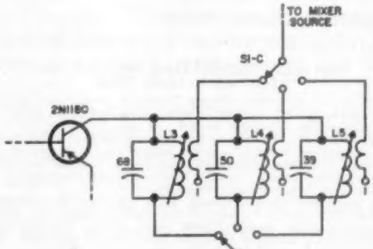

TO MIXER SOURCE
S1-C
2N1180
L3
L4
L5
68
50
39
S1-B
R2
.01

Fig. 2. Alternate circuit employing source injection. Coils L3, L4 and L5 are identical to those in Fig. 1, except that each has a three turn secondary.

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C. L. Peters, K4DNJ
General Secretary
Gilvin Roth Y.M.C.A., Elkin, North Carolina

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holds its own with the 6BZ6-6U8A converter in the ARRL Handbook[2] as regards cross modulation. The overall gain of the FET converter is slightly less than its vacuum tube counterpart, but turning up the receiver rf gain remedies that. Any signal that can be copied with the vacuum tube converter can be copied with the FET converter.

. . . K6DQB

References

1. Harris, "Transistor High-Frequency Converters," **QST**, March, 1963.
2. "A Crystal Controlled Converter for 10, 15, and 10 Meters," The Radio Amateur's Handbook, 1962 through 1965 editions.

Sealing Coaxial Cable

After a coaxial line has been hooked up to an antenna, most hams wrap it with plastic electrical tape and spray it with lacquer to waterproof the cable and protect it from the weather. This method works quite well for a little while, but after several months exposure to heat, cold, rain and our polluted atmosphere, the plastic coating and tape deteriorate quite badly. Also, if the cable flexes in the wind, the tape has a tendency to pull away from the outer jacket. If you use Silastic* Bathtub Caulk instead, the line will stay dry for long periods of time. This material is impervious to moisture and most contaminants and is very flexible. If the cable is cleaned with soap and water before the caulk is applied, it adheres very well and is nearly impossible to remove. It retains its characteristic under all extremes of temperature and even stays quite flexible in very cold temperatures, so it won't crack and peel. I don't have any idea what the terminal life of Silastic* is, but it has not deteriorated at all on cables that I installed six months ago. I already had to replace peeling and cracked tape coverings applied to other cables at the same time.

. . . Jim Fisk W1DTY

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*Registered trademark of Dow Corning Corporation, Midland, Michigan.

Jim Bego K8KWQ
261 Draper
Pontiac, Mich.

WWV on the Mohawk

Mohawk owners who have remounted the crystal calibrator trimmer on the top of the chassis[1] may still have difficulty finding WWV at 10 MHz using the trimmers supplied with the kit. The trimmers have to be connected across the proper main tuning capacitor sections, a job further complicated by the rather small size of the trap door on the top of the cabinet. Another problem is that WWV reception on 10 MHz is unreliable under adverse propagation conditions.

A solution to the problem is a plug-in converter that allows reception of WWV at 5 MHz. Three trimmers are connected across the proper sections of the main tuning capacitor to tune the 40 meter band to 5 MHz. No modifications are made to the receiver itself.

A little investigation uncovers the fact that the stator sections of the main tuning capacitor in use on the 40 meter band are connected to three eyes in the ceramic insulators on top of the frame. These eyes are just about the right diameter to fit standard banana plugs.

The plugs are mounted on a 1¼ x 4¾" piece of ⅛" phenolic or Plexiglass. Drill the holes for three stud-mount banana plugs along one edge, spacing them 2" apart Mount the plugs and check the fit in the main tuning capacitor—do not use any force, the ceramic is rather fragile. You will find that the plugs are a loose fit in the holes, so carefully pry the leaves out to provide good contact and mechanical support.

The trimmer capacitors can be anything handy, but it is much easier to adjust the oscillator if a small ceramic trimmer is connected across a larger value fixed silver mica capacitor. The NPO ceramic trimmer does not drift and holds its setting even when the converter is knocking around in the desk drawer. The final setting of the oscillator capacitor was a total of 200 pF, measured on a capacitance bridge. The mixer and rf capacitances were 110 pF and 151 pF respectively. Choose your trimmers keeping these values in mind. This puts WWV on the 7.1 MHz dial calibration.

Mount the trimmers and fixed capacitors (if used) on the board and wire the unit. One side of each trimmer goes to each of the three banana plugs. The plug closest to the front panel is the oscillator, the next one is the mixer, and the last one is the rf section. Connect the other terminals together and connect a short flexible lead to this tie point. The clip is connected to the frame of the main tuning capacitor and serves as a ground return path for the three trimmers.

When the unit is complete, plug it in and tune the receiver to 7.1 MHz. If the trimmers were not preset it will be necessary to find 5 MHz. Tune a signal generator to 5 mc and adjust the oscillator trimmer until the signal is heard. Peak the mixer and rf trimmers. Now turn off the signal generator and tune for WWV. It should be nearby. Repeak the mixer and rf trimmers and the job is done. Now whenever you want to hear WWV merely tune to 7.1 MHz and plug in the converter.

. . . K8KWQ

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[1] "Mohawk Tip," Giannotti, 73 Magazine, November, 1965, p. 121.

E. H. Conklin, K6KA
P.O. Box I
La Canada, Calif.

High-Pass Receiving-Antenna Filters

Many of us have used a second rf stage, a preselector with tubes a passive tuned circuit ahead of a receiver, or tuned traps to eliminate unwanted signals. This has been with varying degrees of success. The traps probably have been the most effective where their single frequency does the job.

There remain some images in modern receivers, particularly at the second mixer. Also, there are spurious signals produced by one or more local broadcast stations causing a signal to appear at a false place in an amateur band. In my case, an open-wire telephone line crosses the property. It passes one broadcast station seven miles away, and two others about 18 miles away. The difference frequencies move amateur phones into the CW band. KP4CNN said that he had troubles with a transceiver, until he stopped the broadcast-station signals from going through the pi network to the grid of the first receiving tube.

In order to test rejection circuits for undesirable effects, I fed a signal generator into a cubical quad. Then I connected a receiver to a filter and to an 80-meter grounded antenna, trapped for 40 meters. Next time, I shall switch the antennas, for the long wire gave a mismatch for other frequencies, which appears to be the cause of a slight increase or decrease in receiver signal-plus-noise-to-noise ratio on 21 and 28 MHz. The quad in its simple unmatched configuration is useful for reasonably flat standing-wave ratio. However, it feeds a very wide range of frequencies into the receiver, including broadcast band, VLF and even audio (5 and 10 kHz) carrier systems. This pick-up in a quad is far greater than in a horizontal dipole or yagi with a suitable matching device.

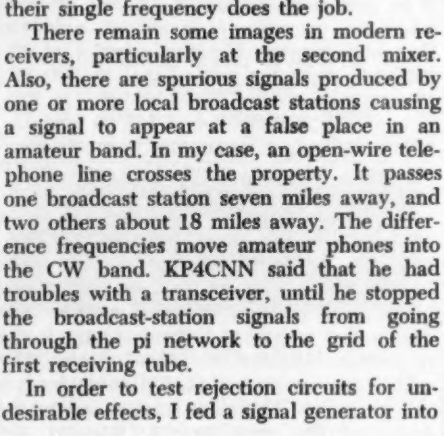

Fig. 1. A two-pole, multiple-circuit rotary switch for inserting various filters in receiving antenna line.

Tuned circuits

In an attempt to improve everything at once, I tried a parallel-resonant tuned circuit mounted in a shield box. This used a link and a tap on the coil for 50-ohm input and output to the receiver and antenna. With it, the desired signals were reduced in strength and were strongest when the circuit was off resonance. This apparently corrected the standing wave reflected by the receiver toward the antenna. The rejection of off-resonance signals was not outstanding.

A pi-wound choke from the antenna lead to ground did not cause any loss of receiver sensitivity measured by SN/N ratio with and without the choke. A capacitor inserted between the choke and ground then could tune the series-resonant circuit to the broadcast band. Although this caused one broadcast station to disappear when tuned out, a station on some other frequency became louder. This also appears to be caused by the reactance of the circuit improving reception on another frequency. Several of these traps probably could have been used to eliminate the three offending stations. This approach was not attractive because of the VLF and audio carriers on the telephone line.

High-pass filters

The next step was to insert a simple "T" high-pass filter in the antenna line, with a theoretical cut-off between the broadcast band and 3.5 MHz. Air Dux coils were tried first, using the inductance given in World Radio Laboratories' catalogs, and checked with a grid-dip oscillator. Convenient nomograms for this appear in the R.S.G.B. Data Reference Book, and in the Knightkit GDO assembly manual. Good performance also was obtained from small one-cent surplus chokes and a sack full of mica capacitors. It was convenient to include in the shield box a two-pole rotary switch with a number of positions. Fig. 1 shows this, which provides connections for straight-through use for inserting a number of devices for comparison.

Filter A had one section. It was designed for a 50-ohm input and output, with a 2.6 MHz cut-off. It used two .0012 μF capacitors in series with the antenna and a 1.5 μH Air Dux coil between ground and the connection between the two capacitors. This attenuated signals a few unimportant decibels in the noisy 80-meter band, as shown in Fig. 2. This and all other filters with a cut-off below 3.5 MHz had an attentuation of 0.5 db or less at 7 MHz and at 14 MHz.

Filter B included a second section without a shield between coils, which should have been provided. The two series capacitors between sections were replaced with one capacitor of half the value. This two-section filter had no attentuation above 3.6 MHz, except for a loss of 4 dB at 21 MHz.

Filter C used a 2.5 μH Air Dux coil, and two .0016 μF capacitors with a cut-off of 2.0 MHz. This produced a gain in receiver SN/N ratio in most of the 80-meter band, and only a 1.0 dB loss at 21 MHz. For simplification, it is not included in the graph.

Filter D used a 2.0 μH miniature choke. This one had a large attentuation at 3.4 MHz, and gains in the mid-band region, disappearing at 4.0 MHz. It also had a slight gain of 0.5 dB at 7 MHz and 28 MHz, with a 1.0 dB loss at 21 Mc. It remains in use, although the increased rejection by a second section would be useful.

Later, in order to eliminate any signals below 10.7 MHz that might beat into the 14 MHz band, another filter was built using a coil of 0.37 μH consisting of four turns air-wound on a ¾-inch diameter, with two .0003 μF capacitors. No signal-generator measurements were made, but the S-meter indicated that there was a very slight loss at 14 MHz, and a large attentuation on the lower amateur bands.

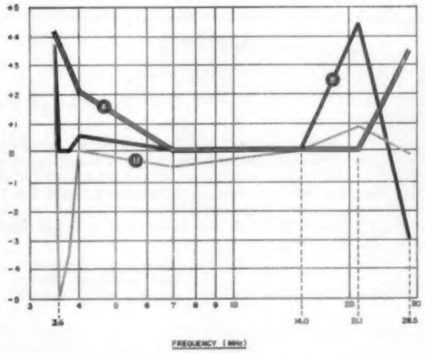

Fig. 2. Attenuation or gain measured with several high-pass filters in the receiving antenna line.

Conclusion

No attempt was made to correct a possibly very poor standing-wave ratio for the undesired frequencies. This might be done with a resistor across each end of the high-pass filter. The impedance then presented to the filter may not deviate very widely from the design impedance. It would reduce desired signals somewhat. Without resistors, some reduction in the adverse effects upon the rejection of undesired signals by the poor match for off-frequency signals, may result from using two or more filter sections.

Lacking an all-band receiver, no attenuation measurements were made in the rejected frequency range. The filters have been used for a number of months. In a few cases, a single-section filter has brought in a weak spurious signal that was not present in the straight-through switch position. About half of the apparent commercial intruders in the 14 MHz band were weakened or eliminated by a filter, where this phenomenon was due to two signals intermodulating within the receiver. It has been interesting to find that high-pass filters were more effective than an added tuned circuit, with less loss.

. . . K6KA

Letters

Up to Date Articles

Dear 73:

Just a short comment on your excellent articles—last year I taught electronics in a high school vocational program and used many of the design and more technical subjects as teaching aids. Your topics are so up to date that I have incorporated some of the circuits I've found in 73 in the R&D laboratory at which I'm presently employed.

Edward F. Steinfeld, Jr.
7587 Roselawn Drive
Mentor, Ohio 44060

73 is Stronger

Dear 73:

It seems that 73 is made from better stuff than Brand X or Brand Y. It is noticeably more difficult to drill holes in 73 than in the other mags. 73 almost stalls a ¼ inch drill with a ⅛ inch bit . . .

Adam Denison, Jr. W4RWH
Bowman Gray School of Medicine
Winston-Salem, North Carolina

1967 International Mobile Rally

Dear 73:

Please announce to your readers that they are all invited to the 1967 International Mobile Rally to be held at RAF Alconbury, Huntingdonshire, England, on 18 June 1967. This rally is jointly sponsored by the United States Air Force and the Amateur Radio Mobile Society. Every effort is being made to provide truly international representation at this rally; correspondence concerning this show should be sent to the Project Officer, Mars Director AJ1AA, International Rally, Rox 3284, APO New York 09238.

George T. Martin, Jr. Capt., USAF
G5ACY

Experiments with Gravity

Dear 73:

I have heard of a national group of some kind involved with amateur experimentation using gravity for communication and/or motivation. I would be very interested in how to contact someone to obtain further information.

Harold Johnson WA6DZL
Box 144
La Puente, California 91747

Can anyone help Harold?

Disappointed

Dear 73:

And now you have come out with a new binding which seems to be very similar to the unmentionables. Contrary to statements it does not stay open on the bench. I cannot even keep it open while I read it. Your articles have always been good, but not really that much better than QST or CQ. If this keeps up I will enter by subscription to S-9 (for CB'ers); at least their magazine stays open.

Jay Johannes WA9OHS
4235 North 68th Street
Milwaukee Wisconsin

Helping Out

Dear 73:

The International Telecommunications Union, the organization established 100 years ago to regulate international communications, will be meeting in the next couple of years. To keep amateur radio and allow it to grow, we need the neutral countries; The Afro-Asian countries who have no need of our bands for propaganda purposes.

A few years back the balance of power was held by the European countries and the U.S., but now because of the one vote per country rule, it is in the hands of the new countries of Africa. This is because she has most of the new countries; we need Africa.

I have talked to many African Students, and the majority of them don't even know what amateur radio is. These are the future leaders, the sons and daughters of the ruling families. If these leading families don't know about amateur radio, we must teach them.

Why don't we start a campaign to educate these students to the good of amateur radio? We all have extra gear in our junk boxes that could be donated to this cause. Interested parties please contact me.

Bill White W3TYV
308 Gaskill Street
Philadelphia, Pennsylvania 19147

All Homebrew

Dear 73:

Here is a photo of my homebrew amateur radio station W9DSP. This equipment is mostly solid state and has been under construction for about three years. That is to say it has been in use for the past two years with about one year of building.

It is obvious to me as a subscriber to 73 that your policy is futuristic and encompasses the solid state concept of the art. It might be enlightening to your readers to publish a picture of this solid state equipment at the amateur level; in the past two years of operating this equipment, almost invariably the station I am working exclaims to me that I am his first QSO with someone who builds, let alone all transistor circuitry. Hi.

Keep up the good work on advanced techniques in amateur radio; we need this information to survive.

Willy Moulton W9DSP
Route 4, Box 136
Chippewa Falls, Wisconsin

Left to right at W9DSP: All transistor receiver covering 3.5 to 30 HMz with room for 6 and 2 in the future; Includes FET's. Power supply and control. 125 watt DC input transmitter; all transistor except for three tubes. Includes VOX, VFO, PTT, five bands. Solid-state electronic keyer. tube-type linear with pair of 572B's and self-contained power supply. And on the shelf, an all-solid state (except CRT) scope and RTTY terminal unit.

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WB4EQX

Jerry Hardison II, first licensed as WN4AEF at the age of nine, now has his general license, WB4EQX. Jerry, now eleven, finds time between his school studies to work 80 CW and 10 and 2 meter phone. He is an avid homebrew builder and he says his first love are the transistor projects from 73. He won first prize at a recent high school science fair with a transistor tester similar to the one in the September 1966 issue of 73. Jerry's OM is W4HQM.

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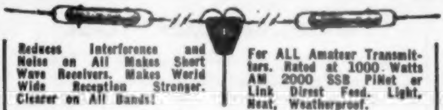

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Technical Aid Group

The first members of 73's Technical Aid Group are listed below. They are willing to help other hams with their technical problems. If you have a concise question that you think can be answered through the mail, why not write to one of the hams on the list? Please type or write legibly, and include a self-addressed stamped envelope. One question to a letter, please.

If you'd like to join the Technical Aid Group and you feel that you are qualified to help other hams, please write us and we'll furnish complete information. It's obvious that we need many helpers in all parts of the country and in all specialties to do the most good. While 73 will try to help with publicity and in other ways, we want the TAG to be a ham-to-ham group helping anyone who needs help, whether they be 73 readers or not.

Don Nelson WB2EGZ, EE, 9 Greenridge Road, Ashland, N.J. 08034. VHF antennas and converters, semiconductors, selection and application of tubes.

Tom O'Hara W6ORG, 10253 East Nadine, Temple City, Cal. 91780. ATV, VHF converters, semiconductors, general questions.

Stix Borok WB2PFY, high school student, 209-25 18 Ave., Bayside, N.Y. 11360. Novice help.

George Daughters WB6AIC, BS and MS, 7613 Notre Dame Drive, Mountain View, Calif. Semiconductors, VHF converters, test equipment, general.

Roger Taylor K9ALD, BSEE 2811 W. William, Champaign, Ill. 61820. Antennas, semiconductors, general.

Jim Ashe W2DXH, R.D. 1, Freeville, N.Y. Test equipment, general.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont St., Falls Church, Va. 22042. General.

Howard Krawetz WA6WUI, BS, 654 Barnsley Way, Sunnyvale, Cal. 94087. HF antennas, AM, general.

Robert Scott, 3147 E. Road, Grand Jct., Colorado 81501. Basic electronics, measurements.

J. J. Marold WB2TZK, OI Div USS Mansfield DD728, FPO San Francisco, Calif. 96601. General.

Hugh Wells W6WTU, BA, 1411 18th St., Manhattan Beach, Calif. 90266. AM, receivers, mobile, test equipment, surplus, repeaters.

Richard Tashner, WB2TCC, 163-34 21 Road, Whitestone, N. Y. 11357. High school student, general.

Wayne Malone W8JRC/4, BSEE, 3120 Alice St., West Melbourne, Fla. 32901. General.

Louis Frenzel W5TOM, BAS, 4822 Woodmount, Houston, Texas 77045. Electronic keyers, digital electronics, IC's, commercial equipment and modifications, novice problems, filters and selectivity, audio.

Michael Wintzer DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Clyde Washburn K2SZC, 1170 Genesee Street, Bldg. 3, Rochester, N. Y. 14611. TV, AM, SSB, receivers, VHF converters, semiconductors, test, general data.

DXERS and DXERS-TO-BE

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What's New for You?

Response to this column has been fairly light so far. I think that part of the reason for this is that the name we've been using doesn't fit what we'd like the column to be. We're open to suggestions for a new name. The column is meant as a forum for short, timely notes that are of interest to technically-minded hams. We're looking for contributions from you, our readers, about new transistors and other components that you've used and found interesting. We also want notes about new surplus, technical conventions and meetings, technical nets and clubs, moonbounce skeds, and comments and corrections to 73 articles. All items will credit the contributor. Please send in your notes as soon as possible so that all 73 readers can take advantage of them. Send to Paul Franson WA1CCH, 38 Heritage Rd., Acton, Mass. 01720.

More Gain for the SB-100

Here's a simple hint from John Butrovich W6GTJ, for increasing the gain of the Heath SB-100, particularly on the 10 and 15-meter bands. It also makes the S-meter a bit s livelier. Simply reduce R-221 from 470 Ω to about 47 Ω. This increases the gain of the receiver considerably by increasing the injection voltage from the LMO to the second mixer. It also seems to improve the signal-to-noise ratio and has apparently caused no problems.

February Propagation Forecast

The symbols and forecast for the February propagation were a bit mixed up. Apparently the January forecast was inadvertantly repeated in February.

ATV Directory

Donald Levine WB2UMF, 150 DeLong Ave., Dumont, N. J. 07628, is trying to compile a list of ATV'ers all over the world. If you're interested in ham television, please send the following information to him so that he can list you in the directory: name, call, address, phone number, equipment for ATV, and whether or not you're on the air now.

Corrections

There were several errors in the schematic for the "Silect Six Meter Converter" in the January issue:

1. There should be a connection between the oscillator tank circuit and 0.001 bypass capacitor to the supply voltage shown on the schematic; the etched circuit board showed this correctly.
2. The etched board layout shows a connection directly from the 12 volt supply to the rf stage tank coil; it should be connected through a 56k resistor as shown in the schematic.
3. The new designation for the Cambion SPC-1 coil forms is *2170-2-3* (1 to 20MHz); *2170-3-3* (20 to 50 MHz); and *2170-4-3* (50 to 200 MHz),

. . . Bob Boyd W1VXV

Phase-locked oscillator

A couple of errors crept into the "Phase-locked UHF Microwave Oscillator" on page 68 of the February issue. The polarities of CR5 and CR7 are both reversed on the schematic. Two R22's are shown on the schematic; the one referred to in the text is 500 ohms. Also, the fifth sentence in the second paragraph on page 74 should read as follows, "If the C_a and C_b used had ranges up to 7-10 pF, the frequency of your initial output should be about 600-750 MHz. When you have determined, with the power meter or receiver . . ."

UHF Multiplier

The circuit diagram in Fig. 1 on page 22 of the February issue ("An Improved Multiplier for UHF") gives the wrong pin numbers for the 6J6 oscillator-multiplier. The plates and grids are interchanged.

G. W. Cunningham WB2SRD

Kyle's Current Controller

John Derby, 1124 Hedgewood Drive, Lafayette, Ind., points out that K5JKX's simple current controller on page 96 of the December 1966 issue is a little too simple. Unless the screen regulator gets its voltage from some other source, it isn't going to work at all as he describes it. While the plate current of the 6V6 remains essentially constant,

DONATE YOUR EYES SO THAT ANOTHER MAY SEE

Great advances have been made over the past 25 years in the repair of damaged corneas, the clear substance that covers the pupils of your eyes. The only material that can be used to make these repairs comes from other eyes—those WILLED by their owners for removal within 4 hours after death, and the degree of success in these operations is astonishingly high.

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The need now is for hundreds of thousands of additional pledges to produce an ever increasing availability. A thousand pledges today may produce no material for many years, so the greater the pledge group, especially among the upper age levels, the greater the chance that many of those who need this transplantation will indeed live to see again.

Obtaining these pledges has been a project of Lions Clubs in many cities, and their members, or Doctors and Hospital Administrators, can direct you to a source of pledge cards which you and your family must complete to make an eye donation valid. Here is a project for entire families. What greater gift could you give to a fellow man!

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the current through the string of NE-2's will vary inversely with R1. If they are drawing about 5 mA at 300 V, they'll draw about 100 mA at an input voltage of 750. Also, Kyle starts out with plate and screen both at 250 V, Screen reg, none!

Amperex Linear IC's

In mentioning these, we're departing from the usual policy of reporting on semiconductors recommended by readers who've used them, but they look especially interesting. Amperex calls one (TAA320) a BIFET —it's a MOSFET and conventional silicon transistor on a single chip, mounted in a 3-lead, TO-18 case. This results in a simple, low-noise, high-gain unit with very high input impedance (10 GΩ). Cost is low, too, around a couple of dollars. Another Amperex IC is the TAA310 class A preamplifier with 100 dB gain for audio use. It's cheap, too. Burstein-Applebee and Newark carry Amperex semiconductors.

. . . Paul Franson WA1CCH

Weatherproofing

Making a dependable weatherproof connection or seal can be a real challenge under certain conditions; it is even more difficult if it is needed 50 feet up a tower between the temperature extremes of 90°F above to −40°F, often conditions in Western Canada. An antenna experimenter, or anyone else for that matter, should look at the most economical weatherproof sealant I've found until now: Roof Shingle Cement, a sticky asphalt compound, available either in cans or in caulking gun cartridges. Any connection, splice or part to be sealed should be tightly wrapped with plastic tape and then covered with one or more layers of this compound. If the treated unit never(?) has to be opened, no plastic tape is needed, just make sure all cavities and holes are sealed to prevent condensation; be sure, because this stuff really sticks. After a while the outside forms a dry skin but the inside remains soft and prevents cracking of the seal. This asphalt compound does not seem to degrade coax lines or other materials; I did not notice any changes in the rf characteristics when used on baluns and loading coils. It is more easily available than any other weatherproof preparation suitable for amateur antenna use.

. . . Bob Fransen VE6TW

Howard S. Pyle W7OE
3434 74th St., SE
Mercer Island, Washington

Climbing the Novice Ladder

Part VI: The formal code exam.

The eventful Saturday marking the formal code test for Judy and Joe dawned raw and chilly. A light mist ushering in the fall season lent further depression to the gray and gloomy atmosphere. Far from being daunted by such vagaries of nature, Judy's ill-concealed excitement allowed her to make but slight inroads into the tempting plateful of scrambled eggs her mother had prepared for breakfast. Far across town, Joe pushed his half-eaten waffle and sausage to one side with the lame excuse, "Guess I'm not very hungry this morning" which resulted in an exchange of knowing smiles between his parents.

Larry had arranged to pick up Joe, stopping by on the way to FN's place, to pick up Judy. Both kids had received their FCC application blanks during the week but without a reminder from Larry, Joe would have left his at home; the more methodical Judy had hers carefully tucked away in her purse when Larry arrived. Pulling into FN's driveway they made a quick dash for the house ducking what had now settled into what looked like a determined all-day rain, as best they could. FN met them at the door and after the usual hearty greetings said, "Well, you kids could have picked a brighter day for an exam but we'll be warm and cozy inside; Ma's got a cherry fire blazing in the living room fireplace; let's go up there and be comfortable." Hot coffee ready and waiting, did a great deal to relieve initial tensions and with the last swallow of the warming fluid FN asked, "You bring your FCC application forms? Larry told me the other day that you'd received them". "Right here Gramps" replied Judy removing hers from her purse while Joe silently retrieved his from an inner pocket. "Fine; suppose you both sit here at the table then and fill in your part . . . here's a couple of pens. I see you brought the little ABC's book Judy . . . use the sample form in Appendix H as a guide. Larry and I will have another cup of coffee and if you hit a puzzler you can ask us about it."

The forms were simple and in a matter of just a few minutes they were ready. "Yours to Larry, Judy . . . I'll take Joe's". Both appeared to be in proper order so FN announced, "Suppose we go down below now and set up the CPO, round up some copy paper and pencils and have at it." No sooner said than done and in a few minutes FN said, "Guess we're all set now; as we have but the one CPO you'll have to work together rather than separately. I've chosen some copy from one of the military manuals; it has mixed letters and figures and some punctuation. Larry has looked it over and agrees that you shouldn't find it too difficult

. . . a rainy day for the exam . . .

. . . the warm-up run . . .

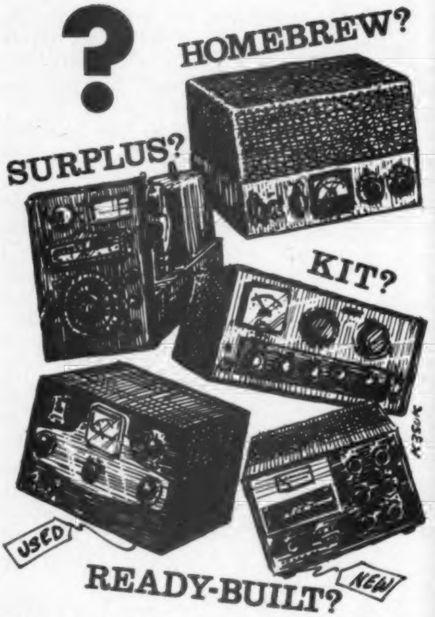
to copy. He seems to think that I have the steadier fist, which is probably just some of his Blarney but he's asked me to do the sending. He will copy right along with you probably hoping that he can trip me on a mis-cue here and there, eh Larry?" "Don't be so modest, FN" replied Larry, "when have *you* ever sent a wrong character?" With a chuckle FN said, "Plenty times . . . plenty, but all right, if thats' the way you want it, remember you asked for it!" I'm going to send just a bunch of random stuff for a few minutes to give you kids a chance to get the shakes out of your writin' hands . . . kind of a 'warm up' run. Copy what you can but remember, if you're doubtful about a character don't hesitate to puzzle over it . . . Just skip it and go right on." With that FN commenced with the attention sign and continued in a slow, steady rythm, sending sentences from the book in front of him. Joe and Judy industriously copied with complete concentration for what seemed an interminably long time. At last FN wound up with a flourishing 'SK' and the two kids laid down their pencils with long, relieved sighs. "Well, how'd you do?" came from FN. "I dunno Gramps," said Judy; "for the first minute or so it seemed like a bunch of jibberish to me but then I began to catch on and it came a lot easier; maybe I didn't do *too* bad". "let's see" said FN, reaching for her paper and passing it to Larry with, "You look it over Larry, I'll see what Joe did with it". Taking Joe's copy, FN checked it character for character with the copy from which he'd been sending, then passed the book to Larry who in turn re-checked Judy's effort. "Looks pretty good here FN" and unseen by either youngster, Larry slipped a sly wink toward FN who acknowledged with a slight nod. "Now" said FN, "before you kids do any more copying, suppose you take a little break from the pencil and limber up your wrists on the key; you'll have to send as well as receive you know and you don't want to be stiff. Judy, suppose you send this short paragraph for a warm-up session; we'll all copy . . . you too, Joe . . . and see what you can do." Judy took the book and starting where FN had indicated steadily plugged along to the end of the paragraph. "Now Joe", FN said, "take the next paragraph and Judy you copy *him* this time along with Larry and me." When Joe had completed his run, FN carefully checked against the book and then mystified both of the kids by exchanging broad grins with Larry. This was immediately explained though when FN said, "Congratulations; you have both passed your sending and receiving tests with a good safety margin . . . nice goin.' " "How come," Joe said . . . "was *that* the exam?". Laughingly FN replied, "It sure was Joe; a little psychological trick I picked up long ago when I first commenced to examine novices. Almost invariably they'll be much less tense and at greater ease if they don't *know* they are being formally examined and think it's just a 'practice run'; had you fooled didn't we? Larry and I had this all fixed up beforehand and you walked right into our little trap and obviously to your advantage. Here's the results; we had already counted characters in the material you sent and received so it was possible to quickly gauge what you did when you finished. Joe, in your receiving test, you came up with five errors in the five minute run; in four cases it was that same old letter 'Y' that has been plaguing you. The other error was that of omission; you apparently missed a character, let it go and went on with your copy, as you should. However, three times in the five minutes you copied 25 or more characters solid; any one of these solid copy stretches would have passed you. You got a little added break in one run; it contained three figures and a punctuation mark; remember, these all count as *two* characters in the final score but even without that bonus, you made it; very good lad. Now Larry, what did you find in Judy's copy?". "Error-wise, she did better than Joe, FN; Judy you chalked up only three errors but they occurred at points which left you, like Joe, with three complete 25 character strings, more than ample to pass you. Two of your errors were in figures so that cost you four characters really, plus the other one which was copying an 'x' for a 'y' and counted as a single error, so you and Joe were actually just about even. FN, what did you figure your sending speed to be?" "I tried to hold it as close to 5wpm as I could judge Larry," replied FN, "but maybe force of habit sneaked it up a bit on me for I was actually sending at an average speed of slightly over 6wpm . . . say about 6¼, so if either of the kids had failed, I'd have had to run it over and bring my speed down to exactly five". Beaming faces and broad smiles from both kids greeted these remarks and then Judy chimed in with an eager question. "How about our sending then; tell us about that". Nodding to Larry, FN said, "Go ahead Larry and give Judy an analysis of what you think of her fist".

"Well Judy, I'm going to give you a baby Oscar on that one; you've developed a nice, clean steady fist and your character formation is excellent as I think FN will agree. I clocked you at just slightly over 6wpm . . . perhaps FN's sending cued you in at that speed. More than you needed but even better so. You made only two errors in the entire five minute run; one was in adding an extra dot to the figure 7, the other was in making a period where it should have been a comma. Now let's see what FN's got on Joe. "This time I'm going to give Judy the edge on Joe," FN said, "remember, I copied both of them. Judy's sending was steadier than Joe's. It was evident that he was crowding himself a bit for speed. You came out at exactly 7½wpm Joe, probably through a sub-conscious feeling that maybe you weren't quite making your required five. As a result, your sending was a bit jerky; you'd have made better characters and fewer errors had you held down to 5 or 6wpm, however you made readable copy in two runs of better than 25 characters each which, of course, passes you. You made seven errors scattered throughout; here's your paper—I've marked the mistakes and you can check them against the book." While Joe was checking his copy, Larry gathered up the miscellaneous papers while Judy's relief was evident in her completely relaxed slouch in her chair. "I'm wondering about something," said FN, "in this past week you kids have both taken a rather sudden spurt in cour copying speed—you been practicing together a lot this week?" "Nope". Judy replied, "Joe phoned me and said that Larry had shown him where to find the code practice transmissions on the amateur bands and he told me where to look for them. So, we both tuned 'em in on every schedule we could possibly make. That sure helped—they came through on both of our receivers just like we were in the room with a CPO. A little QRM at times but plenty of good solid practice. Boy, I'm really sold on copying actual signals—makes you concentrate a lot harder, doesn't it Joe?" "Right" returned Joe, "I sure got in a lot of good licks with my old BC-312". "Swell," came from FN, "stay right with it—you're going to be shooting now for the 13 wpm you'll need for your General class exam within the year and you'll get a lot of help from the CP stations. Don't relp too much on copying other hams at random, particularly the novice group. You'll find all kinds of fists, good and bad but the CP stations practically all use automatic tape transmissions which is perfect character formation and that's the type of transmission you'll have to copy at the FCC office when you take your General exam. Well, we've got about an hour before lunch time; do you want to talk about transmitters for a bit? If you pass your written tests you know, you're free to get on the air the minute you receive your license and call letters from FCC; be a good idea to start thinking about what you're goin' to use for transmitters". Eagerly Joe said, "Gee FN, I'd sure like to start doing something about a rig; I'd like to get on the air just as soon as I get my license". "Me too," Judy chimed in. "I'm getting kinda anxious to talk back to some of these stations I'm hearing all the time. My little CONAR receiver is sure hauling 'em in and I'm getting so I can read quite a bit of what they're saying".

"All right" said FN, "let's see what we can do about it. There are several ways in which you can acquire a proper transmitter for your novice operation and, if you plan right, it can be a piece of equipment which you can carry right over into your General class activity when you reach that stage. First off, is the 'home-brew' approach. While I'm a great believer in the ham building as much of his equipment as possible, I'm going to discourage this angle for you kids. Here's why; you can build a very satisfactory little rig from scratch by following one of the many designs for simple rigs in any of the handbooks or from one of the magazine articles. Sometimes, this is the least costly approach moneywise although the time element for such construction will penalize you a bit. Ordinarily, like you kids, the novice will have little in the way of a 'junk-box' which hams call the miscellaneous accumulation of parts and components which they inevitably gather as their ham career progresses. The amateur with a couple of years or so of ham background can generally pull about 50% or more of what he'll need to build a piece of gear, right out of his junk box collection. However, if practically everything you'll need to put together a novice transmitter must be purchased new, money saving is a bit questionable. On top of that, the relative inexperience of the novice hardly lends itself to producing a really presentable job particularly if he is unequipped with such convenient tools as socket punches, hand or electric drill, nut-drivers, soldering iron and similar items. To have to buy these in addition to parts runs the cost figure to a pretty substantial sum. In my opinion, the novice is really better off to take another approach and defer the major home-brew construction until he is a little better equipped all ways. And what other approach do I recommend? There are several; let's examine them.

"You can buy a brand new, factory assembled and wired transmitter, ready to go. There again, you're going to face a rather substantial cost item. And, by so doing, you won't learn anything about electronic construction; just adjustment and operation. The older hams term this approach 'being an appliance operator'—just a 'button pusher and knob-twirler' as it were. Later on in your ham career, after building a number of pieces of equipment, you can think seriously about buying some good factory-built job. You'll find then that through the experience gained in building a few items from scratch, you can handle a commercially built job much more effectively through a better understanding of the functioning of the various components.

"Another approach is to buy a good, used transmitter if of a reliable make, free of modifications and including the factory instruction book; this latter is important both for operation and maintenance. Here again however, you gain little in furthering your knowledge of electronic construction but you will effect quite a substantial saving over the cost of a new piece of gear. Then too, there are always the kits and they are far from a poor bet for the novice. In addition to being priced considerably below a factory completed job, they do give you a certain amount of assembly and wiring experience which you won't get on a complete factory built job. Too, the really hard work is done for you such as holes punched and drilled in chassis and panel, panel lettering applied and many little niceties accomplished for which you would require a rather impressive list of special tools; pliers, screw driver and a soldering iron just about cover the major tool requirements for putting together a kit.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The novice transmitter . . . to buy or build, kit or surplus, homebrew or factory assembled?

"Personally, I favor for the novice, either buying a new kit of reliable manufacture or, as second choice, a good used transmitter of well-known national make. Both of you kids have catalogs of the leading kit makers, Knight-Kit, Heathkit, Johnson and others. I'm going to suggest that you go through these carefully and see what you can find that is suitable for novice operation and priced within your budget. While you're thinking these over, make another round of our three local electronics stores and see what they may have on their used equipment shelves. In general, it is better that you avoid a piece of surplus military gear; there are lots of good items among them but ordinarily they are not completely adapted to novice operation without considerable modification which, while relatively simple for the experienced ham is usually a little bit rougher than beginner should tackle.

"Suppose then, you do as I suggest; study your catalogs and visit the stores. When you think you've come up with something that looks like it might fit your picture, come on out and we'll talk about it. Meanwhile, don't forget that while you've satisfactorily passed your code tests, you still have the written examination ahead so keep right on boning in the little books . . . you'd hate to think you'd made the code and then flopped the written portion, wouldn't you?

Assuring FN that they most certainly would keep on with their study, they agreed to his suggestions and as lunch time was fast approaching, all three loaded into Larry's 'Gallopin' Gertie' for the homeward trek shouting their "73" to FN as they drove off.

. . . W7OE

Hand Buffer

Some of the homebrew specials look a bit rough at times due to the use of heavily tarnished surplus connectors. The average amateur has no means for cleaning them easily and soaking in any kind of solvent does more harm than good. Many connectors, materials and other parts are often very fragile and impossible to clean with sandpaper or solvent. One of the best and easiest ways of cleaning these things after trying everything else is by using a so-called "suede leather brush" as a hand buffer. This is a small brush made with copper clad steel wire and intended for cleaning and sprucing up suede leather shoes. These brushes can be real life savers to a home builder and work wonders on tarnished silverplated rf connectors and similar parts. They are also a great help in cleaning a plated chassis without scratching it, cleaning files, etc. At 25-30 cents these brushes are a real buy.

. . . Bob Fransen VE6TW

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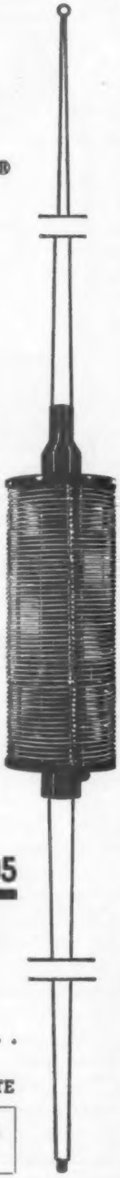

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Heathkit HW-32A 20 Meter SSB Transceiver

When Heathkit brought out their single-band transceivers a little over three years ago, they immediately became very popular. They were low in cost, versatile, compact and ideal for the ham who wanted to move up to SSB with a minimum of effort. Now the people out in Benton Harbor have gone one better—they have introduced a new set of single-banders with even more features than the original.

These new single-banders feature upper and lower sideband selection on all models, improved audio and AVC response, automatic level control (ALC) input for external linear amplifiers and improved design and styling. The nicest feature of all is that all these additions are available at no additional cost. In fact, the price is even lower than the original models. With prices increasing everywhere, it's refreshing to see a new piece of amateur equipment offered with a lower price tag.

Heath's famous quality is evident throughout the entire HW-12A, 22A and 32A line. This borne out in on-the-air performance; both the receiver and transmitter have been designed for optimum SSB performance and show it. The 1 μV sensitivity, 2.7 kHz selectivity and slow AVC action make for very enjoyable SSB operation. The 200 watt PEP of the single-banders isn't going to crack any DX pileups, but all continents can be worked without a great deal of effort. In only a couple of days of part-time operation WAC was made from W1DTY with excellent reports.

For the ham who wants to work mobile, the HW- series is really the ticket. Mobile performance with the HP-13 DC power supply is excellent. A mobile mount is supplied with every unit and the front-panel bias control speeds up conversion from fixed station to mobile use.

In the receiver, the pentode section of a

6EA8 is used as an rf amplifier. The triode section mixes the input signal with the VFO to provide an output at the 2304 kHz *if*. This combination results in a sensitivity of 1 μV for a 15 dB signal-plus-noise to noise ratio.

The four-crystal crystal filter following the mixer exhibits 2.7 kHz selectivity at the 6 dB points and 6 kHz selectivity at 50 dB down. Two 6AU6 *if* amplifiers, a 12AT7 product dectector and a 6EB8 audio amplifier and power stage complete the tube lineup in the receiver.

A 6EA8 microphone amplifier and cathode follower in the transmitter drive a diode type balanced modulator. The output of the balanced modulator is amplified by a 6EA8 transmitting *if* amplifier before the signal is fed into the crystal filter. From the crystal filter the signal is amplified by another *if* amplifier, a 6AU6, and then mixed with the VFO signal in a 6EA8 mixer stage. In the final a 12BY7 driver stage pushes a pair of 6GE5's to 200 watts PEP input.

The Heath single-band transceivers may be switched from transmit to receive by either push-to-talk or the built-in VOX circuitry. The 6AU6 VOX amplifier is normally operated in a saturated condition, but when audio is applied to the grid, the plate voltage rises and fires a neon bulb, providing positive switching action. The voltage from the NE-2 neon is amplified by the relay amplifier, the triode section of a 6EA8, which operates the transmit/receive relay. The built-in antitrip circuitry and VOX delay result in very smooth VOX operation. The VOX delay and VOX sensitivity controls are located on the rear panel where they are easily accessible during initial VOX adjustments; after that they may be virtually forgotten.

A 6AU6 is used in a Colpitts type VFO circuit and the stability characteristics are excellent. The circuit is completely temperature compensated and after a warmup of 30 minutes, the drift is less than 200 Hz per hour. To a large degree, the stability and drift characteristics of this VFO are directly attributable to its relatively low frequency of operation—1618.3 to 1771.7 kHz. The VFO output is mixed with the output from a crystal controlled heterodyne oscillator to obtain the required mixing signal for 20 meter operation.

The back-lighted dial is very smooth—much smoother than some transceivers I have used costing several times as much. The two kHz dial calibration is very convenient and when used with the optional crystal calibrator, you know exactly where you're operating without a lot of interpolation. In these new single-banders the crystal calibrator socket is built in and the calibrator is controlled from the front panel—all you have to do is build the calibrator.

Construction of the HW-series single-banders is simplified by the use of a printed circuit board and a factory-prepared wiring harness. In fact, over 90% of the components are mounted on the printed circuit board. With this type of construction, assembly time is drastically reduced and wiring errors are almost non-existent. With the extensive directions and pictorial layouts provided in the assembly manual, wiring proceeds smoothly and rapidly. Even the alignment is no problem—all you need is a broadcast receiver, a VTVM with an rf probe and a

Heathkit HW-32A Specifications

Frequency coverage:	14.2 to 14.35 MHz.
Sensitivity:	1 μV for 15 dB signal-plus-noise to noise.
Selectivity:	2.7 kHz at 6 dB; 6 kHz at 50 dB.
Spurious responses:	Image rejection, 60 dB; if rejection, 65 dB.
Carrier suppression:	45 dB below peak output (minimum).
Sideband suppression:	45 dB below peak output with 1000 Hz modulation (minimum).
RF power input:	200 watts PEP.
Antenna impedance:	50 ohms nominal.
Frequency stability:	Less than 200 Hz per hour after warmup.
Features:	Selectable upper or lower sideband, external automatic level control (ALC), VOX, improved audio and AVC circuitry.
Tube lineup:	6EA8 microphone amplifier and cathode follower, transmitter if amplifier and relay amplifier, and rf amplifier and receiver mixer; 6AU6 VFO, VOX amplifier, if amplifiers, and transmitter mixer; 6BE6 VFO cathode follower, 12AT7 product detector and carrier oscillator, 6EB8 audio amplifier and audio output, 12BY7 driver and 6GE5 (2) rf power amplifier.
Accessories:	HP-13 DC power supply, HP-23 AC power supply, HS-24 mobile speaker and HRA-10-1 100 kHz crystal calibrator.
Power requirements:	12.6 volts at 3.75 amps, 800 Vdc at 100 mA, 250 Vdc at 100 mA and —130 Vdc at 5 mA.
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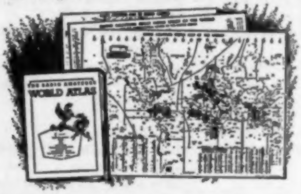

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dummy load. All the tuned circuits are prealigned at Benton Harbor, so it only takes a few minutes to get everything tweeked up.

Operating voltage for these transceivers are furnished by an external supply—either the HP-23 for fixed station use from 117 volt lines or the HP-13 for mobile use. The supplies are wired internally so they may be turned on and off with the function switch located on the front panel of the transceiver. The filament wiring is a series-parallel arrangement which balances the filament voltage without power-robbing dropping resistors.

I have used the HW-32A on 20 meters for several months now, and the audio and carrier suppression reports are always excellent. During a recent DX test the HW-32A with a linear amplifier added a couple of new countries to my WTW list. Whether you are an AM'er still procrastinating against SSB or are simply looking for a new mobile rig, the Heathkit HW- single-band transceivers are the most economical units available. They are dependable, compact and versatile—a tremendous value on today's market.

. . . WIDTY

Mobile Mike Holder

Many times the new owner of a mobile mike finds himself without a mike holder. If you are in this predicament, and your mike is the type with the button mounting as used by Shure and others, here is a possible solution.

The only material required will be a short length of rectangular extruded aluminum (or waveguide).. This is available in many different sizes and most metal supply houses and surplus metal stores will be able to furnish the extrusion. The dimensions are not at all critical. A recommended stock size would be ½ x 1 with a .125 wall thickness. The maximum length required is 4".

On one side of the extrusion drill and file a ⅜" wide slot that will accommodate the button hangar on the rear of the mike. The slot should be about 2-3" long. On the opposite side drill clearance holes for two sheet metal screws that will be used to secure the holder to the automobile.

The appearance may be enhanced by anodizing or painting.

. . . Larry Kinner K6VNT

Proper Terminology

If you want to become known as an expert in any field, and this is particularly true of ham radio, there is no substitute for knowing and using the proper technical language. Obviously, it's more difficult to impress friends and acquaintances if they have no trouble understanding what you're talking about.

To help you overcome this problem, the following easily understood words and phrases are translated into terms calculated to make you stand out as an authority. Thus,

Don't say	**The proper term is**
It has a handle	The unit is portable even if it weighs 500 lb
The darned thing won't work	It needs refinement
I made a lucky guess	It was a matter of interpolation
I poured the coal to it	I worked to maximum operating parameters
I don't know why the circuit works	It's a sophisticated circuit
My gear is the most expensive on the market	This gear is the ultimate in precision equipment
I cut and tried until it worked	The problem was solved by empirical means
It won't work	There are technical problems
The whole dammed thing blew up	This ranges from temporary setback to catastrophic failure
Lucked out	Persistent effort resulted in phenomenal success

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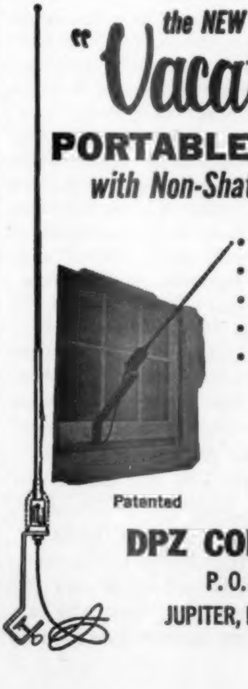

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Part 23

This trip from Burundi to Kigoma was a real hair raising experience let me tell you. Over swinging bridges, over very deep gorges, very bad roads, and no road signs at all. A great many animals were seen that night, leopards, lions, even three gorillas, many, many hyenas and countless other animals, many of them I don't even know the name of. Some even John said he had never seen before and mind you he had been down there for a number of years. The road was just about as bad as the Bhutan/Thimphu road which many of you have seen my color slides of. We took off with plenty of spare gasoline, oil, water, a few sandwiches, and two thermos bottles of coffee, all of which was consumed on the trip to Kigoma. This was by far the worst part of Africa I have ever seen, before or after, its real "wild country", very primative natives, some half dressed some not dressed at all. The men-folk were all painted with no smiles from any of them either. It was one of those trips that really gives a car a good going over. Luckily we had no car trouble. I forget the exact mileage between the two places. As near as I remember it was something like 125 miles, and it took us until the next afternoon to get there, some 15 hours to drive 125 miles—that's mighty slow progress but it was the best we could do on that primative road. Things down there are run very odd. The first thing you do when you get to any village, town or city you check with the police, even if you are only going to be there a few minutes or hours. The fact that I was going to leave almost immediately had nothing to do with this formality. To the police we went. After a long wait we finally were ushered into the chief's office. He was of course a native, wanting to know why we were there, where were we going, etc. After talking to him and filling out half a dozen forms we were permitted to depart. He told us we were permitted to stay there only two hours! These people down there like to throw their authority around when they have a chance, and this fellow was no exception. He let you know this from the time we entered his office until we departed (Gladly too!). We headed straight for the railway station, stopping at a market place on the way. I bought a big bunch of very large bananas for 47c to eat on the train (they lasted all the way to Johannesburg, South Africa). Funny thing tho, I still love bananas. After buying the bananas, I tried taking a few pictures of the market place, and boy this caused quite a rucus, let me tell you. One well-dressed fellow (a native), yelled something at me and John in their native tongue and people started coming our way, with very mean looks on their faces, John said get in the car and I did and away we QSYed very QRQ. You don't have to understand peoples' language to know when they are mad—and this fellow was—MAD—. Boy you very soon learn certain things down there, and picture taking without their permission is one thing to not do. They want some shillings for this permission. Anyway we got to the railway station and I mean by the time we stood in line with all those other natives I guess I had absorbed some of the prevailing smells. With my ticket in my hand we headed for my cabin on the train. I mean to tell you I just got settled and away the train departed. I am one of these fellows who hate to be late, but this time we could only blame that chief of police for delaying us so long in his office and his waiting room. These people absolutely will not be rushed. Don't lose your time trying to make them speed up. In fact I dare say that's when they actually slow up. You just grit your teeth and bear with the situation, and try to figure some other way you will do it the next time. John jumped off the train, saying, "See you from Bouvet Is." or something like that and the train headed away from Kigoma towards Dar-es-Salaam. I started off the trip by eating one of those bananas, and saying to myself, Gus, you asked for it and here it is. You wanted to see Deep Africa. Well you are seeing it and HOW. There was no air conditioning on this train and there were no first class reservations, etc. You just mingled with the natives. If you don't like it just GET OFF, the only other way is to WALK. No busses, airlines, no roads. It's that train or walk. I was headed for a place called Itigi in central Tanganyika where I were going to catch an African bus to take me in the direction of South Africa. The trip to Itigi took all night, and about 4 PM the next day we arrived there. I was smutty, smelly, tired, and probably looked like the other natives by this time, and I just did not give a hurrah either. I wanted to, let's say, "go native", and that's what I had become, or at least that's how I felt about this time. Off the train and to the bus station I headed with all my gear and about three bearers loaded up. I watched them all the way. I could not afford for anything to be missing when I got to Bouvet. Things have a very bad habit of disappearing when you travel like I was doing, and each piece of my luggage was just like a chain. It's no good if one single item is missing. If it is you are stopped cold in your tracks. I did not want this to happen to me, that's why I always stuck very close to my gear. As is usual in these parts, the bus was late. In fact it was what you might say VERY LATE. The bus I was taking was from Nairobi. It arrived about two hours late. I had my bus ticket all ready and when it arrived and I saw all those people waiting for that bus, I made up my mind that I was going to be one of the passengers on it. I had all my bearers standing by with my luggage and had been instructed what to do. When the bus stopped they immediately piled my stuff on top of it, I handed the bus driver a tip and then my ticket, he motioned me into the very front seat. About half of those waiting were left behind and the bus was crammed full with not even room for anyone else to stand. Remember there are no paved roads in these parts of Africa, at least when I was there they were not paved, and I doubt they are right now. The roads is what you might say "like a washboard" and the bus driver drove at the EXACT SPEED to make each washboard groove felt. I kept thinking of my poor equipment on top of that bus, bouncing around and numerous loose connections developing to cause me headaches later on. The top of this bus was really loaded up. Bicycles, boxes, radio gear, chickens, and many bags containing Lord knows what. Oh yes I brought my bananas along with me from the train. About this time I ate two of them to sort of get my mind at ease. After a while you get thirsty you know, now where do you get water from? The bus finally stopped to unload a few and take on a few more passengers, every one headed for a well with a rusty bucket and drew up water that was yellow looking, and it even had a sort of evil smell to me. I had saved a paper cup from the Itigi railway station and filled it full of this rough-looking water and drew out one of my "water purifier pills" and dropped it in, after shaking it a while the pill dissolved and down my throat it went. About all I can remember about it was it was wet, warm, nasty but at least it was water. Natives flagged down the bus along the way and by pushing and shoving once in a while one more could get in. If I had been blind I could have told you I was in Africa. Everyone was washed down with sweat, dirt, and lots of clothing I am sure had never been washed. After a while you get to the point where you just don't smell anything at all. I suppose I sort of smelled like them at this time. I was treated with respect all the way, they gave me a whole seat, even when the bus was loaded down with only standing room. The bus traveled all day and stopped at sundown at one of the "tourist huts" along the way. It cost me one dollar to spend the night at these places. They served you a cup of tea when you arrived and in the morning they would wake you up in time for the bus and gave you another cup of tea. Fairly good beds with mosquito netting on it were to be found at each of these places. The bus would usually come and get me first than go past the little bus station and pick up the other passengers who had been sleeping on the ground around the bus station. At lunch time the bus usually took me past one of

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the tea rooms along the way where a fairly good dinner could be had at a fair price. This was the only good meal I would have each day. During the late afternoon you know a feller gets hungry. I finally got to the point where I would down those dried salted little fish and dried salted other meat along with the natives. It did not give me any trouble that I know of. This is one time that I "went native". I remember we stopped one day at a roadside tearoom in Northern Rhodesia. The temperature was around 110 degrees, and this tea room had a sign outside reading, "Admitted only with tie and coat". In I walked in my shorts, only a white (it was white one time anyway) shirt. They "ordered me out". I tried to explain that the temperature was 110 degrees and was too hot to be wearing a coat and necktie, that all my clothing was on top of the bus and that I was hungry and wanted some food! This did no good whatsoever, and I ended up not getting anything from that place. Back I went along with the natives and ate along with them some more dried fish and that OTHER dried meat, some very hard bread, very dark and dirty looking stuff. I knew how it was to be not admitted in a high class place. I even tried offering them double prices to let me eat there. I DID NOT LIKE THIS TREATMENT AT ALL I must say. For over three or four days I did not see a white face. I was seeing Africa the hard way, this I must admit. At every country border the bus stopped and we all went in the little Custom House and always the questions were about the same. Did I have any firearms, did I have any ammunition, did I have any alcoholic drinks, did I have any tape recorders, did I have any TRANSISTOR RADIOS. My answer was of course NO to all these questions. At no one single check point was my baggage opened and inspected. All that radio equipment went all the way from Itigi, Tanganyaki to Johanesburg, South Africa without once being opened! I guess they figured anyone traveling on an African bus could not have anything of value along with them. My first stop was with Shorty, VQ2EW (I think that's his call). with his nice wife. Shorty had plenty of cold Cokes in his Fridge (as they call it). I understand that Shorty and his wife are now back in ZS6 land where he was originally from. He drove me all around showing me the native quarters, market place, and I met many of his friends there. Shorty and his wife were very wonderful hosts to me. I installed my equipment on his operating table and had many a fine QSO with my friends in the USA and other countries. I told them about the proposed trip to Bouvet and Tristan da Cunha and Gough Islands. Shorty had a fine Quad installed and boy it brought in the results with my rig connected to it. The SWR was quite high, about three or four to one as near as I remember, with no noticeable ill effects as far as I could tell. These fellows down there have some mighty fine openings to the USA. You should hear those S-9+++ sigs pouring through, hour after hour down there. I wish those same fellows would come through like that over here. I used to listen across the bands doing a little eave dropping on the fellows. Sometimes I would hear someone say, "I wonder where Gus is right now" and I would call them and say I am right here, "what can I do for you?" This kinda shook them up I suppose. But it was lots of fun. I got caught up on my eating at Shorty's home but time to depart arrived and away I was again, heading for Johanesburg on that African bus. It was the same old thing all over again only MORE SO! We passed the tremendous Zambazi Falls which to me looked a lot larger and more rugged than Niagara Falls ever looked. It was late in the afternoon when we stopped there and too late to take any pictures. I did take a few but none of them turned out on account of not enough light. We went through Southern Rhodesia and then through a portion of Bechuanaland (ZS9) without any stops except to eat. I had no chance to try to get a "operating permit" there on account of the tight schedule to get to Capetown for that Bouvet island boat trip. Bechuanaland was a very miserable looking spot, at least the portion we traveled through. After it came South Africa. It was the most dramatic change of scenery I have ever seen. It was like moving from Africa of the 1800's to modern-day America. Right at the border the rough washboard, unpaved road changed to a big wide asphalt highway. It sort of reminded me of half of the New Jersey Turnpike. Later on I found this type of road was to be found practically all over South Africa. That's it for this month fellows. BOUVET HERE I COME.

. . . Gus

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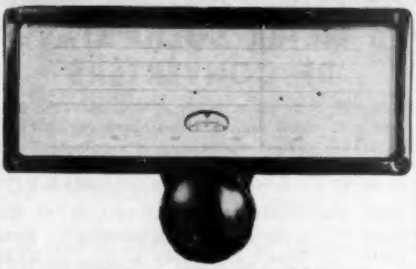

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WTW Certificates

Here is a complete list of all WTW recipients since the beginning of the program on May 1 1966. There were several errors in the list given last month that weren't discovered until the magazine was already on the press. This list is up to date with proper certificate numbers, band and mode.

14 MHz SSB WTW 200

1. Bob Wagner W5KUC
2. Gay Milius W4NJF
3. "Hop" Hopple W3DJZ

14 MHz SSB WTW 100

1. Gay Milius W4NJF
2. Bob Wagner W5KUC
3. "Hop" Hopple W3DJZ
4. Bob Gilson W4CCB
5. Jim Lawson WA2SFP
6. Joe Butler K6CAZ
7. Warren Johnson W0NGF
8. Lew Papp W3MAC
9. George Banta K1SHN
10. Dan Redman K8IKB
11. Paul Friebertschauser W6YMV
12. Jay Chesler W1SEB
13. James Edwards W5LOB
14. Bill Galloway W4TRG
15. Olgierd Weiss WB2NYM
16. Jose Toro KP4RK
17. Gerald Cunningham W1MMV
18. John Scanlon WB6SHL
19. Edward Bauer WA9KQS
20. Dick Tesar WA4WIP

21 MHz SSB WTW 100

1. Ted Marks WA2FQC
2. James Lawson WA2SFP
3. Joe Hiller W4OPM

14 MHz CW WTW 100

1. Vic Ulrich WA2DIG
2. James Resler W8EVZ
3. Dan Redman K8IKB

21 MHz CW WTW 100

1. Joe Hiller W4OPM

(W2NSD from page 4)

teurs working for the overall benefit of our group of hobbies. Well, damned few.

The idea seems to be let George do it. Well, there isn't any George.

Techs on Ten?

Still another letter asking why not Techs on ten meters. The complaint is that the Tech doesn't have any code practice available up on six meters and that when someone does try to send some code he gets cat calls from other Techs.

I never heard so much clap trap in my life. Any Tech . . . or anyone else . . . that wants to learn the code can do it the way most of us have done: sit down and copy it. You don't need a transmitter or even a license to learn the code. All you need is a receiver and enough gumption to sit there for a few days writing down all the tripe you can decipher until you can read it at thirteen per.

DXpeditions

Sometimes I wonder how DXing was thirty years ago, just before I came into ham radio, before the ARRL DXCC and Honor Roll came into being. I wonder if DX operators were hounded right off the air from every relatively rare spot by the QSL head hunters? I wonder if the great bulk of the DX contacts in those days were for the purpose of getting a QSL or were perchance for the joy of the contact itself?

Now that I've operated from dozens of countries around the world I realize that a kilowatt transceiver, a three element beam up 70 feet and a few days just for hamming will give me DXCC from anywhere in the world. And if I don't have to spend too much time working I can get up in the 300 plus country list in a year. I don't need much in the way of brains, though they help, obviously, or even any technical knowledge, just persistance.

Having DXpeditioned myself a bit and being on excellent terms with many of the top DXpeditioners, I don't want anyone to think that I am intending to be in any way critical of the chaps who put on DXpeditions. But . . .BUT. . . DXpeditions have brought on a very dangerous situation and, unless some major changes can be made in

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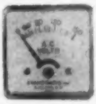

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2N3704-06 asstd plastic silicon xister	10 @	1.00
2N1300 asstd, PNP & NPN, ¼" leads	25 @	1.00
2N1714 sil. power 10 W, 60 V TO-5	4 @	1.00
2N456A ger. power 7 A, 40 V		.45
2N1021A gen. power 7 A, 100 V		.60
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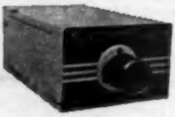

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the DXCC rules, my present thinking is that all of us should do as little as we can to encourage them.

Whoa, don't jump to any conclusions. Not one of you reading this even have an inkling of what I am about to say, save perhaps the chosen few of you who have had the privilege of visiting some of the rarer countries and are familiar with their political problems.

Here and there around the world I've visited places or received letters from spots where a DXpedition has left some ruffied feelings. This happens, of course, but it is relatively rare and seldom does this result in any serious repercussions to local or following amateurs.

The real problem is this: in several countries around the world amateur radio is tacitly permitted, only don't ask for a license. A visiting amateur goes to the licensing authorities and is given a shrug. Go ahead and operate, but please don't ask me to sign anything because if there is any trouble I don't want the responsibility. It's like our own State Department, no one wants to be responsible.

All goes well. Our visitor goes on the air, contacts a few thousand stations, makes everyone happy, and departs for greener pastures. Then, sometime later, comes the bomb. A letter comes to the government from the ARRL asking if the amateur had a license. The letter stirs up a hornet's nest and the Minister of Communications, if he doesn't lose his job or even his head, is going to be mighty careful about saying yes to the next ham visitor.

The ARRL has decided, for some reason, that it is up to them in some cases to determine the validity of a DXpeditioners license. This, unfortunately, can cause grave international complications. And we certainly don't need any such problems right at our present time in history where we are waiting to see whether the countries of the world are going to get together and take our bands away from us. Right now we should be doing everything in our power to prove the value of amateur radio to the small countries of the world, not causing serious internal political complications through base stupidity.

Well, at any rate, since there is little possibility that the League is going to stop meddling with foreign governments, perhaps we should try to work from the other end of the street and do what we can to discourage DXpeditions from now on. This is simple, just stop sending those generous donations which are supporting the DXpeditioners. When the money stops the DXpeditions will stop. This is lot easier to stop than the ARRL and may be the better solution. The next time you reach for your checkbook just remenber that you may be doing a lot more harm than good to amateur radio.

Public Relations

The number of licensed amateurs dropped by about 5% last year, the FCC has reported. Things slowed down coincident with the ARRL announcement of RM-499 and Docket 15928, the official outcome of 499, is coincident with the unparalleled loss of interest in our hobby.

What's done is done. We can hope that it won't happen again. The board of the ARRL moved last May to prevent something like this from surprising us by requiring that the ARRL executive committee check with the board of directors in the future before sending any further earth shaking petitions to the FCC. It's too bad that barn door wasn't closed before RM-499. The executive committee cooked up 499 and sent it along in without consulting the members or, apparently, even the full board of directors.

So, at a time in history when it would be most prudent for us to be fruitful and multiply we find that our ranks are thinning. We need strength today to hold our amateur bands. This means that continued growth is basic to our survival. Unfortunately there is little being done to promote our growth. Here we are, plunging into the electronic era, and the leading scientific hobby is withering away faster than it grew a few years ago. With over half of the population of our country under 21 we should be experiencing a record growth, with radio clubs starting in high schools all over the country.

What is the problem? You know as well as I. No publicity. Or at least very little publicity and no organized promotion at all. We should be making sure that the youngsters are made well aware of amateur radio and we should get cracking on this or we will be in deep trouble.

How can we get the word out? Lordy, we have one of the most interesting hobbies ever invented . . . all we have to do is just tell people about it. Right now we're not doing this. This is not a job for one man or even one radio club, it is the job of a large

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CUMULATIVE INDEX
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organization, one that is geared to handle something of this size.

The ARRL could, if it wanted to, reverse the tide. And it could do it this year. By increasing the membership dues by 50c per year or by increasing their advertising rates in QST by a mere 10% they could have a whopping fund to hire a good public relations firm which would make sure that the entire country knew about amateur radio is short order. We would be having articles on our hobby in all of the major magazines regularly . . . Look, Life, Post, Boy's Life, True, Playboy . . . and on down the line. A PR firm could coordinate the writing of articles and get them into magazines, newspapers and even on television.

Perhaps it is time you phoned your director and bugged him to get this going and going right now. We can't wait until 1968. This is not the time for a study or a committee, it is time for PR. The directors meet only once a year, in May, this month, so if they don't get this through right now they won't even have a chance until a year from now to start on it.

I can't go into all of the details here without writing a large book, but I think I can give a good answer to any possible argument that can be brought up opposing ham PR. For instance, should anyone suggest that the raising of membership dues by 50c will be catastrophic you might ask them if they are aware of the dues that most other national organizations charge club members. If you belong to any other clubs you know that most of them are $10 to $15 or so a year and this usually includes a smaller magazine than QST. And QST's advertising rates are about one third to one fourth those of any other magazine comparable in another field, so they could easily increase these rates anytime they felt any need for extra money.

It won't hurt a bit to talk up the PR thing on the air and get as many fellows as possible to call their director. There is no time to lose. Unfortunately most directors are "too busy" to get on the air so you'll have to use the land line.

In addition to the top notch writers in our ham ranks such as Jean Shepherd (K2ORS), the most published author in Playboy and winner for two years running of their coveted award for the best story of the year, we have the vitality of thousands of ham clubs. If the League were interested in pushing PR they would encourage clubs to promote ham programs on broadcast radio and television all over the country and to acquaint our public officials with our hobby. There is a tremendous job to be done.

It is all up to you. I'll be watching the fine print in QST for this year's report on the board of directors meeting to see what our future looks like.

Irrelevant Note

One of the nice things about living up here in the backwoods of New Hampshire is that you can go to a country auction every Saturday night. The darndest things turn up there. The other night I lucked into a bunch of those old wooden jig saw puzzles I dig those the most and snapped them for a dollar. Back in the early thirties we used to rent them from Womrath's and our whole family would struggle over a thousand piecer on holidays. Then came those confounded cardboard puzzles, stamped out instead of hand cut. Ugh.

Now and then I rent a puzzle from an outfit in New York. It's nice when the bends are loaded on weekends. Say, if any of you have some of those wooden puzzles you're thinking of throwing out, even if a piece is missing, let me have a chance at it.

I'm also keeping a weather eye peeled for a pottery kiln, in case anyone around the East has one extra. I can swap a complete press for making QSL cards with a half dozen trays of type. Or what do you want?

And we're looking for a pet type Burmese kitten. That's about all.

. . . Wayne

Liberian Field Day

If you need Liberia for WTW, your big opportunity is just around the corner. The Liberian Radio Amateur Association will hold its Third Annual Field Day Activities on April 29 and 30. The club station EL2FD will operate SSB on 14303 and 21303 kHz from 1400 to 0100 GMT on Saturday and from 0900 to 0100 GMT Sunday. A CW station will be on 14103 kHz. The RTTY boys will have a chance too—that is if the teletype equipment at EL2FD will work. Look for them on 14090 kHz.

The purpose of this annual field day is to demonstrate amateur radio and encourage the local people to become hams. QSL cards will be sent to every station contacted. The QSL cards are on hand and will be filled out on the day of contact.

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NEW PRODUCTS

Knight-Kit Solid-State Regulated Low Voltage DC Supply

The new Knight-Kit solid-state power supply, with continuously variable 0-40 volts DC and 0-1.5 amperes output, provides an ideal source of power for transistor circuit development in the shack. This power supply, the model KG-663, is regulated for both line and load variations and features variable current limiting which automatically limits short-circuit current to a safe value. Two meters on the face of the supply simultaneously monitor voltage and current. A heavy-duty operation/standby switch allows presetting of output voltage with the load disconnected; pilot lights indicate standby and operate conditions. This supply also has fine and coarse voltage controls, a rear terminal strip for remote programming and sensing and isolated plus and minus voltage. These units are designed so that they may be stacked for series/parallel use.

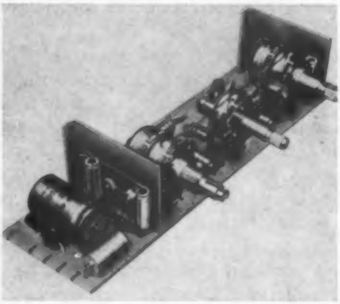
The KG-663 supply is very well filtered and regulated for low ripple output; less than 0.6 millivolts rms at full load. It is available in kit form for $99.95, or completely factory assembled for $149.00 from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.

Apollo Tie Clasps and Desk Plaques

Apollo Engraving, 191 N. Hickory Street, North Massapequa, New York 11758, is marketing a new line of tie clasps which are very neat and attractive and would make nice gifts and awards. Selling, delivered, for only $1.50, the background is black, call letters white, and there is a commercial mike attached to the edge, giving it a very professional appearance.

Apollo also makes call letter desk plaques, on laminated plastic board 2¼ x 6 inches, in black, mahogany, walnut or blond oak, with white call letters, and mounted on a clear plastic base with a metal edges, looks great on the operating table. This sells delivered for only $2.50.

Amperex Printed Circuit Assemblies and Kits



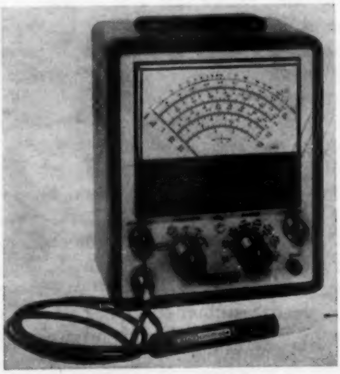
Amperex Electronic Corporation has just announced the introduction of a broad line of printed circuit assemblies and kits for the experimenter and hobbyist. The printed circuit assemblies are available for immediate distribution and the kits will be ready for June deliveries. These new units are designed for use in ham gear, home entertainment equipment, public address and intercom systems. Printed circuit assemblies presently available are 1 watt, 2 watt, and ¾ watt amplifiers using either 9 or 14 Vdc, several models of stereo amplifiers, a tape preamplifier and a 20 watt monaural amplifier. The amplifiers are available in various configurations that include tone controls, balance controls, no level set controls; an arrangement is available to suit nearly any requirement. For further information, write to Amperex Electronic Corporation, Semiconductor and Receiving Tube Division, Distributor Sales Department, Hicksville, Long Island, New York 11802.

Lafayette Spring Catalog

LAFAYETTE
RADIO ELECTRONICS

Layfayette has just announced its new Spring 1967 catalog with the latest in electronics and hi-fidelity. All of Lafayette's own top-rated components as well as equipment from many of the top manufacturers are represented plus a special six page clearance section with a host of values. There is a complete selection of ham gear, test equipment, tools, hi-fi components and electronics parts included. For your free copy write to Lafayette Radio Electronics Corporation, 111 Jericho Turnpike, Syosset, Long Island, New York 11791 and ask for catalog number 673.

Eico Professional VTVM



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● 10	27	62		150
12	30	68		160
13	33	75		180

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AMPS	400 PIV	600 PIV	800 PIV	1000 PIV
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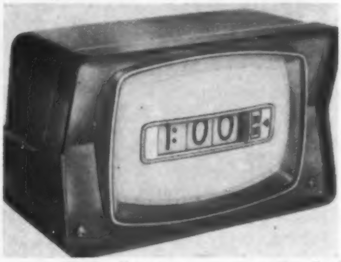

If you don't have a numeral clock in your shack, the new Tymeter Colorama Tele-Vision Lamp Clock may be just what you're looking for. This clock has a good looking face and is available in several color combinations that will fit any decor; persimmon/white case, walnut case, or white case, priced respectively at $14.95, $13.95 and $13.95. These clocks have a built-in light and come with a one year guarantee.

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The new ATV Research Television Catalog is just chock full of goodies for the amateur television enthusiast. This catalog features a brand new transistor television kit, transistor camera parts for "do-it-yearself" experimenters including focus-deflection coil kits, tripods, lenses and all types of vidicon camera components. If you want to get on the ATV bandwagon, this catalog lists everything you need to get your station going. For a free copy, write to ATV Research, Post Office Box 396, South Sioux City, Nebraska 68776.

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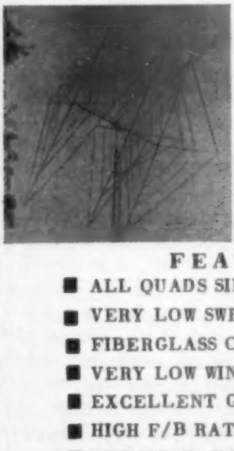

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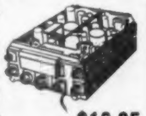

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MAY 1967

ISSUED APRIL 1

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EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7	14	14	14	14	14
ARGENTINA	21	21	21	14	14	7	14A	21	21	21	21A	21A
AUSTRALIA	21	21	14	14	7B	7B	14	14	14	7B	14	14
CANAL ZONE	21A	21	14A	14	14	14	21	21	21	21A	21A	21A
ENGLAND	14	14	7A	7A	7	14	14	14	14	14	14A	14
HAWAII	21	14	14	14	7	7	14	14	14	14	14	14
INDIA	14	14	7B	7B	7B	14	14	14	14	14	14	14
JAPAN	14A	14	14	7B	7B	7B	14	14	14	14	14	14
MEXICO	21	14	14	7A	7	7	14	14	14	14	14	21
PHILIPPINES	14A	14	14	7B	7B	7B	14	14	14	14	14	14
PUERTO RICO	21	14	14	14	7	14	14	14	14	21	21	21
SOUTH AFRICA	14	7A	7	14	14	21	21	21	21A	21	21	14A
U. S. S. R.	14	7A	7A	7A	7	14	14	14	14	14	14	14
WEST COAST	21	21	14	14	7	7	14	14	14	14	14	21

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7	7	7	14	14	14	14	14
ARGENTINA	21	21	21	14	14	7	14	21	21	21	21A	21A
AUSTRALIA	21	21	14	14	14	7B	14	14	14	7B	14A	21
CANAL ZONE	21A	21	14A	14	14	14	14	21	21	21A	21A	21A
ENGLAND	14	7A	7A	7A	7	7A	14	14	14	14	14A	14
HAWAII	21	21	14	14	14	7A	7A	14	14	14	14	21
INDIA	14	14	14	7A	7B	7B	14	14	14	14	14	14
JAPAN	14	14A	14	14	7B	7B	7B	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14A	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	21	14A	14	14	7A	7A	14	14	21	21	21	21A
SOUTH AFRICA	14	7A	7	7A	7A	14	14	14	14A	14A	21	14A
U. S. S. R.	14	7A	7A	7A	7	7A	14	14	14	14	14	14

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14A	14	14	14	7	7	14	14	14	14	14
ARGENTINA	21	21	21	14	14	7	14	14	21	21	21A	21A
AUSTRALIA	28	28	28	21	21	14	14	14	7	7	14A	21A
CANAL ZONE	28	21	14	14	14	14	14	14	21	21	21A	28
ENGLAND	14	7A	7A	7	7	7	7	14	14	14	14	14
HAWAII	21A	28	21A	21	14	14	14	14	14	21	21	21A
INDIA	14	14	14	14	14	7B	7B	7B	14	14	14	14
JAPAN	14	14A	14A	14	14	14	7	14	14	14	14	14
MEXICO	14	14	14	7A	7	7	7	14	14	14	14	14
PHILIPPINES	14	21	14A	14	14	14	7	14	14	14	14	14
PUERTO RICO	21A	21	14	14	14	14	14	14	14	21	21	21A
SOUTH AFRICA	14	7B	7	7A	7B	7B	14	14	14	14	14A	14A
U. S. S. R.	14	14	14	14	7	7	7	14	14	14	14	14
EAST COAST	21	21	14	14	7	7	14	14	14	14	14	21

• Very difficult circuit this hour.

* Next higher frequency may be useful this hour.

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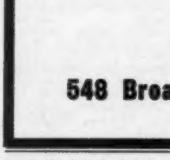

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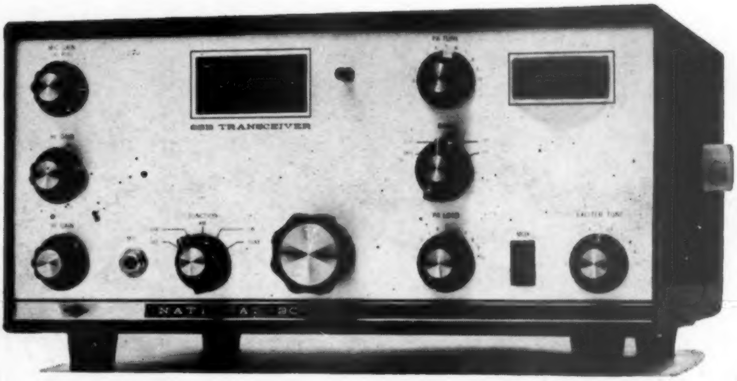

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